Exploring the Cognitive Biases of Lonely People: A Social and Cognitive Approach

by

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Abstract

Current theoretical models of loneliness postulate that lonely individuals show attentional biases for rejection stimuli in social contexts (Bangee & Qualter, 2018), and memory biases for social information (Gardner et al., 2005). Further, it is suggested that these cognitive biases in lonely individuals then induce passive behaviour and social withdrawal (Cacioppo & Hawkley, 2009; Qualter et al., 2015; Spithoven, et al., 2017). The current thesis included two studies that sought to examine the cognitive biases in lonely people using cognitive experiments and observations of social behaviour.

The first study in the current thesis comprised three cognitive paradigms (serial recall, emotional stroop, and directed forgetting tasks) to investigate whether lonely people showed cognitive biases for task-irrelevant information. To explore the bidirectional relationship between loneliness and cognitive biases over time, a longitudinal component to the cognitive study was included. Seventy-seven university students completed the cognitive tasks at Time 1; 23 participants of the original sample group took part in Time 2. The Time 1 results showed that loneliness was associated with memory biases towards social threat information. The longitudinal study showed a bidirectional relationship between the two factors: a higher level of loneliness was linked to a memory bias over time, and a memory bias had a significant impact on the level of loneliness across two time points. Such findings suggest that cognitive biases may have a causal effect on the maintenance of loneliness: for example, perhaps a heightened recall of socially threatening information may perpetuate the belief that people are hostile and unfriendly (Cacioppo & Hawkley, 2009).

Study 2 used an observational method to explore behavioural withdrawal and social perceptions of lonely females in a same-sex friendship. One-hundred and sixteen female university students (58 friendship dyads) took part in a 15- minute filmed social interaction followed by questionnaires rating the interaction quality and friendship quality overall. The results showed that lonely individuals demonstrated a passive interaction style, whereas friends of lonely individuals showed more positive social behaviour towards their friends. In terms of their ratings of interaction quality, both members of the dyad rated the interaction as poor quality, but lonely individuals gave more negative ratings to themselves and their friends. The results suggested a strong link between loneliness and negative cognition in social interaction. The implications of the results of both studies for theoretical models and interventions is discussed.

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Chapter 1: Introduction

Previous research suggested that lonely individuals are characterised by a specific cognitive bias: they see their social world as more threatening and punitive, expect to be rejected by others, and remember more negative social information after social interactions (Hawkley & Cacioppo, 2010). According to the current theoretical models of loneliness (for example, Cacioppo & Hawkley, 2009, Qualter et al., 2015; Spithoven, Bijttebier & Goossens, 2017), the cognitive bias includes hyper-vigilance for social threats and maladapted behavioural features, such as withdrawal and inefficiency in social interactions. Much research examining loneliness has found evidence to support those ideas.

Empirical Definition

Loneliness, defined by Peplau and Perlman (1981), is an unpleasant feeling that occurs when there is a perceived discrepancy between the actual and desired quantity or quality of one's social relationships. Peplau and Perlman (1982) outlined three important characteristics of loneliness: (1) it results from a deficit in one's social relationships, (2) it is a subjective experience, and (3) it is an upsetting and distressing feeling. Loneliness is not only an aversive emotional state because it also appears to serve an adaptive function; from an evolutionary perspective, loneliness facilitates an individual's reconnection to people when they perceive they are isolated from others.

Evolutionary Theory of Loneliness

From an evolutionary standpoint, loneliness is adaptive and signals social pain, which motivates people to reconnect. That is because the need to belong is an innate drive that manifests in nearly all human beings (Baumeister & Leary, 1995). Homo-sapiens tend to bind together and form social relationships for survival and assistance benefits (Baumeister & Leary, 1995). It is argued that loneliness serves the same function as other fundamental needs, such as hunger, thirst, or pain that signal an individual's need to seek remedy of the unpleasant state (Cacioppo, Cacioppo & Boomsma, 2014). Thus, loneliness is an aversive signal that motivates an individual to renew old relationships or build new relationships to increase one's sense of security, and ultimately benefit the chances of survival of one's genes (Cacioppo et al., 2014).

Different Types of Loneliness

The experience of loneliness is an 'internal emotional state' (Asher & Paquette, 2003, p. 75). Because it is a subjective experience, individuals can feel lonely for different reasons. Prior research proposed that loneliness is not only influenced by the quantitative characteristics of one's social relationships, such as frequency of social contact or number of friends (Cacioppo, et al., 2014), but it is also more significantly influenced by the qualitative appraisals of those relationships, such as satisfaction with the relationship or perceived social acceptance (Asher & Paquette, 2003; Cutrona, 1982; Jones, Hobbs & Hockenbury, 1982; Wheeler, Reis & Nezlek, 1983). This means that people can feel lonely in a crowd, and quite happy in moments of solitude.

The experience of loneliness is universal across age, race, socioeconomic status, physical attractiveness, height, weight, body mass index, education, scholastic aptitude, grade-point average, or the number of roommates (Cacioppo et al., 2000, Medora & Woodward, 1986; Neto & Barros, 2000). However, the characteristics of a lonely person are not well defined (Horowitz, French & Anderson, 1982). Given the subjective nature of loneliness, the experience of loneliness will differ between individuals (Horowitz, et al., 1982; Rokach, 1988). For example, feeling lonely can be a temporary response to changes in social situations or it can be chronic distress that is related to various psychosocial maladjustments. Heinrich and Gullone (2006) argue that loneliness can be explained differently according to how many prototypic features are experienced by the individual. Those prototypic features are considered to be the "hallmarks of loneliness". Rokach (1988) argues that the experience of loneliness can be categorised into four main components: self-alienation, interpersonal isolation, distressed reactions, and agony. Each element consists of several subfactors representing an aspect of feeling of loneliness, see Table 1.1. Individuals' experience of loneliness differed in the total of 23 subfactors. Rokach (1988) argues that although lonely people may report feeling all four elements, they may not report experiencing all the sub-factors. Therefore, identification of the different combinations of the prototypic factors of loneliness is important in loneliness research and may lead to the categorisation of loneliness.

Rokach's Tri-Level loneliness model. Table 1.1 shows Rokach's (1988) Tri-level Loneliness Model in detail. The model summarises four key components: self-alienation, interpersonal isolation, agony and distressed reaction that act co-ordinately in

determining the feelings of loneliness. According to Rokach (1988), none of the factors can determine loneliness on its own.

The first component, **Self-alienation** is the feeling of isolating oneself from his/her core and identity. The major sub component of Self-alienation is **Emptiness and Self Void**, which contains two sub factors: *emptiness* and *Depersonalisation*. *Emptiness* refers to the inner deep nothingness and blankness, while *Depersonalisation* refers to the feelings of detachment from one's core identity and often links to the feelings of absence from reality.

The next component is **Interpersonal Isolation**, which refers to being isolated or feeling alone, as well as lacking of the intimacy or quality of social relationships. This component includes 3 sub components: **Absence of Intimacy, Perceived Social Alienation** and **Abandonment**. **Absence of Intimacy** refers to lacking a meaningful relationship. It has 2 sub factors: *Lack of closeness to others* and *Missing a specific person or relationship*. *Lack of closeness to others* is characterised by not having someone to relate, connect and share oneself with. *Missing a specific person or relationship refers to* absence of intimacy of a relationship that is either already ended or have never been experienced. **Perceived Social Alienation** refers to the perceptions of being rejected and isolated. This feeling is subjective, it does not relate to whether the person is isolated from others or being rejected by others. Perceived Social Alienation has two sub factors: *Disconnected* and *Social Rejection*. *Disconnected* refers to not feeling included or not feeling belonged to a meaningful relationship, a social group or society. *Social Rejection* highlights the experience of being actually rejected by others, it contains two level 3 factors: passive and active social rejection. Passive social rejection refers to the feelings of not belonged to or not supported by the social environment, whereas active social rejection refers to the feelings of being rejected, isolated, cut off deliberately by others. The third component of Interpersonal Isolation is **Abandonment**. Abandonment refers to the feeling of being left behind or abandoned purposefully by others. It includes two sub-factors: *Intimate rejection* and *betrayal*. *Intimate rejection* refers to the person feeling rejected by an intimate associate, such as parents or partners. *Betrayal* refers to the feelings of being betrayed, deserted or unaccepted by others.

The third component of loneliness is **Agony**, which is the feeling of pain, hurt, anguish and suffering. The Agony category consists of *Inner turmoil* and *Emotional upheaval*. The Inner Turmoil consists of three sub-component: Defencelessness, Confusion and Numbness; the Emotional upheaval consists of Uncertainty, Pain, Discomposure and Anger. This category emphasises the inner suffering and confusion in relation to the feelings of loneliness.

The fourth component of loneliness is **Distressed Reactions**. Distressed Reactions involves the feeling of the acute pain and suffering experienced when feeling lonely, it includes the physiological, social and cognitive distress related to the feeling of loneliness. In comparison with the Agony category, the Distress Reactions portraits a more acute level of suffering. Distress Reactions includes the subcomponent of *Physiological and Behavioural Distress, Self-Depreciation, Self-generated social detachment and Immobilization*, which highlights the maladjustment in social, cognitive and behavioural functioning related to the feeling of loneliness.

Table 1.1. *Rokach's Tri-level Model of Loneliness (1988)*

<table>
<tr><th colspan="10">Loneliness</th></tr>
<tr><th>Self-Alienation</th><th colspan="3">Interpersonal Isolation</th><th colspan="2">Agony</th><th colspan="4">Distressed Reactions</th></tr>
<tr><td>Emptiness and Self-void</td><td>Absence of Intimacy</td><td>Abandonment</td><td>Perceived Social Alienation</td><td>Inner Turmoil</td><td>Emotional Upheaval</td><td>Psychological and behavioural Distress</td><td>Self-depreciation</td><td>Self-generated social detachment</td><td rowspan="2">Immobilization</td></tr>
<tr><td>Emptiness

Depersonalisation</td><td>Lack of closeness to others

Missing a specific person or relationship</td><td>Intimate rejection

Betrayal</td><td>Disconnected

Social Rejection:

<u>Active</u>

<u>Passive</u></td><td>Defencelessness

Confusion

Numbness</td><td>Uncertainty

Pain

Discomposure

Anger</td><td>Somatic Complains

Behavioural Stress</td><td>Social Comparison

Self-doubt</td><td>Withdrawal

Active separation</td></tr>
</table>

Because feeling lonely is a painful and isolated experience, people's experience of loneliness varies in qualitative ways. The next section describes two popular typologies of loneliness that are categorised by (1) endurance of loneliness and (2) the satisfaction of different social needs.

Prolonged and chronic loneliness. Numerous studies have investigated the importance of distinguishing loneliness as a temporary state compared to a stable persistence trait (Jones, 1987). Loneliness in some individuals is prolonged, while for others it is less durable (Heinrich & Gullone, 2006). Therefore, many researchers (e.g. Young, 1982) have posited the differences between state loneliness and trait loneliness.

According to Young (1982), transient loneliness is characterised by temporary distress and situational suffering. In contrast, chronically lonely individuals are characterised by a series of psychosocial problems and maladaptive physiological functions that may lead to chronic health problems and clinical diseases (Hawkley & Capitanio, 2015). Heinrich and Gullone (2006) suggest that when feelings of loneliness become a long-term problem, loneliness will lead to more negative affect, an unhealthy attributional style, and social skills problems. Empirical evidence supports those ideas, with Hojat (1983) finding that those experiencing chronic loneliness scored higher on global loneliness, anxiety, depression, neuroticism, and external locus of control. Moreover, chronically lonely individuals tended to have fewer intimate social relationships compared with situationally lonely people. Chronic loneliness is also a significant predictor of shyness, fear of rejection, and social skill deficits (Solano, 1987).

Furthermore, previous research outlined that a small group of people tend to report prolonged feelings of loneliness, experiencing social and emotional isolation from others over many years (Qualter et al, 2015). According to Hawkley and Cacioppo (2010), there are negative consequences of prolonged loneliness: cognitive, affective and behavioural impairments that created alteration in genetic, neural and hormonal mechanisms which increase morbidity and mortality in old age. For example, Hawkley et al. (2012) suggest that lonely and non-lonely individuals differ in the hypothalamic–pituitary–adrenal axis (HPA) activation when exposes to stressors. The HPA axis is the central stress response system of all vertebrates, it interlinks the nervous system and the endocrine system and regulates the production and release of corticosteroids. Moreover,

it controls physiological and behavioural adaptations to the environment (Denver, 2009, Hawkley et al., 2012). The maladaptiveness of chronically lonely individuals' stress response has been shown in relation to changes in gene expression, an increased likelihood of glucocorticoid resistance (Hawkley et al., 2000), and a flattened diurnal cortisol rhythm (Doane & Adam, 2010). Consequently, prolonged lonely individuals develop a frequently activated HPA axis which leads to further psychological and behavioural malfunction (Cacioppo et al., 2000). Moreover, chronically lonely individuals have a different attributional style compared with individuals who experience transient loneliness (Vanhalst et al., 2015). Specifically, chronically lonely adolescents have a stronger tendency to attribute social inclusion to external factors whilst attributing social exclusion to internal and stable factors (Vanhalst et al., 2015). Those findings, regarding the differences between chronic and transient lonely individuals, suggest that chronic lonely individuals have different psychosocial, physiological and behavioural responses to everyday circumstances than that of transient lonely individuals.

Weiss's typology of loneliness (1973). Weiss (1973) categorised the loneliness experience into social loneliness and emotional loneliness. Social loneliness refers to a lack of a sufficient social network while emotional loneliness refers to an absence of quality social relationships (Weiss, 1973). According to Weiss, social relations provide various social functions. Weiss outlines six social provisions that can be obtained by different types of social relationships. They are attachment, social integration, reliable alliance, guidance, reassurance of worth, and opportunity for nurturance (Weiss, 1973). Weiss argues that, in order to stay healthy, an individual should have different specialised social relationships to fulfil these social needs. Some relationships can provide fulfilment of several social functions, for example, spousal relationships. However, no particular relationship can fulfil all the functions. Loneliness may occur when individuals are unsatisfied with one or a combination of several social provisions. Specifically, Weiss (1977) argues that social loneliness tends to occur when there is an absence of social integration, while emotional loneliness tends to occur when there is an absence of close attachment in social relationships (DiTommaso & Spinner, 1997). Hoza, Bukowski and Beery (2000) compared the differences between lonely children who lacked a network of peers and lonely children who lacked a close dyadic

friendship. They argued that social loneliness and emotional loneliness are distinct phenomena in children as well as in adults.

Three dimensions of loneliness in relation to one's attentional space (Hawkley, Browne, & Cacioppo, 2005; Hawkley, Gu, Luo, & Cacioppo, 2012). Hawkley et al. (2005) outlined three dimensions of loneliness according to one's attentional spaces: intimate loneliness, relational loneliness and collective loneliness. The intimate loneliness refers to the absence of a quality relationship within one's intimate core social circle of up to five people, for example, parents, partners and best friends. This is a replication of Weiss's emotional loneliness. The relational loneliness replicates Weiss's definitions of social loneliness, that is the absence of a regularly visited social circle consisting of 15 to 50 people that provides instrumental support: for example, frequently contacted friends and families (Hawkley et al., 2005). The collective loneliness refers to how likely a person can connect to others with similar social identities in a collective space or the outermost social layer (Dunbar, 2014) that includes 150 to 1500 people.

Prevalence of Loneliness

A recent survey suggests that 1 in 10 people in the UK report feeling lonely (Office for National Statistics, 2015). For the distribution across age, loneliness was displayed as a U-shape curve with people under 25 and older than 65 being the most lonely (Victor & Yang, 2012). Loneliness is particularly salient among university students (Wiseman, Guttfreund, & Lurie, 1995). A study conducted by Knox, Vail-Smith, and Zusman (2007) found that in the East Carolina University in the US, 25.9% of male students and 16.7% of college female students had severe feelings of loneliness.

Measurements of Loneliness

Loneliness is a complex construct. It is a multi-faceted phenotype with numerous factors influencing its origin, development and duration (Murphy, Murphy & Shevlin, 2015). Because the nature of loneliness is subjective, no objective ratings of loneliness can measure loneliness accurately (such as number of friends or the scale of one's social networks). Therefore, the problem with measuring loneliness, and defining a clinical lonely group has always been discussed within the academic community.

The first problem of measuring loneliness is that theories and measurements of loneliness do not correspond with one another. The most acknowledged definition of loneliness is Weiss's (1977) multidimensional view of loneliness, which identifies two different types of loneliness: social loneliness and emotional loneliness. The multidimensional view indicates that the manifestation of loneliness are different across different social domains, for example, family loneliness, friendship loneliness, romantic loneliness (Russel, 1982). Therefore, loneliness should be measured along those different dimensions, and scores should represent those different aspects.

However, the most common measurement of loneliness, the University of California at Los Angeles (UCLA) Loneliness Scale (UCLA loneliness scale), is based on a unidimensional view of loneliness, which argues that loneliness can be estimated as one score that reflects one's social relationships as a whole. Therefore, it is noticeable that the most frequently used measurement of loneliness does not correspond with the most established definition of loneliness (Oshagan & Allen, 1992).

Other popular loneliness measures include both multidimensional and unidimensional measures. The typical multidimensional measure includes the de Jong-Gierveld Scale (de Jong-Gierveld, 1987). The de Jong-Gierveld Scale Scale is an 11-item measure for assessing adult loneliness level which was developed in a sample in Europe. The scale includes 6 items measuring the dimensions of emotional loneliness and 5 items measuring the dimensions of social loneliness. The scale can be used as either unidimensional or multidimensional measure of loneliness, depending the type of research question being examined (Toma´s, Pinazo-Hernandis, Donio-Bellegarde & Hontangas, 2017).

Another commonly used multidimensional measure is the 37-item Social and Emotional Loneliness Scale for Adults (SELSA) by DiTommaso and Spinner (1993). That measure is derived from Weiss's concept of loneliness, and measures emotional (family and romantic loneliness) and social loneliness.

Despite the dispute between theoretical issues surrounding loneliness and its measurement, the UCLA loneliness scale is the most frequently used measure of loneliness. The advantages of using such a measure are that it is relatively short, easily administrated, and has a good internal consistency, construct validity, discriminant validity and test-retest reliability (Russell, 1982). It is also highly correlated with the

single item loneliness measure (r = .40 to .60; Schmidt & Sermat, 1983) and demonstrated to be distinctive from the correlates of loneliness', such as depression and self-esteem (Russel, 1982). The current thesis uses the UCLA loneliness scale as the measure of loneliness because of those qualities it possesses. More importantly, the UCLA scale was developed based on college students' experiences of loneliness, thus making it appropriate for use with the sample in the current thesis.

Cognitive Models of Loneliness

There are conflicting theories about how loneliness leads to different emotional, cognitive, and behavioural responses in relation to social relationships. Contemporary models include the Regulatory Loop (Cacioppo & Hawkley, 2009), the Reaffiliation model (Qualter et al., 2015), and the cognitive aspects of loneliness inspired by the Social Information Processing Model (Spithoven et al., 2017).

Regulatory loop (Cacioppo & Hawkley, 2009). Cacioppo and Hawkley (2009) proposed a theoretical model of loneliness that addressed the cognitive, behavioural, and affective features of lonely individuals, see Figure 1.1. Specifically, they argued that feeling lonely causes individuals to become hypervigilant for social threats. Accordingly, lonely people may attend to, and remember, more negative social events. These biases, in turn, increase the likelihood of the individual constructing a more negative social world and holding negative expectations of social interaction. These cognitions may trigger individuals to alter their behaviour in social situations in a negative fashion, such that they produce more negative social interactions, which then confirm they are socially inept and produce more undesirable social interactions. These cognitive and behavioural maladaptive features may increase the activation of stress responses, which leads to other malfunctions, including heightened cognitive load, diminished sleep quality, and negative health impacts such as increased morbidity and mortality (Hawkley & Cacioppo, 2010).

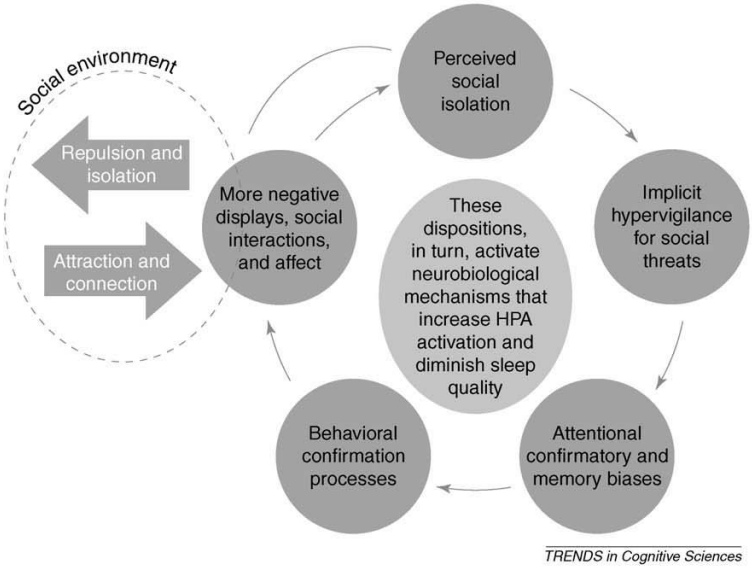


Figure 1.1 Regulatory Loop, Cacioppo & Hawkley (2009)

Re-affiliation model (Qualter et al., 2015). As a way to extend the theory of the Regulatory Loop, the Re-affiliation Model was developed, as shown in Figure 1.2. Within the Re-affiliation Model, the aversive feeling of loneliness is viewed to initially trigger withdrawal from social situations. At the same time, loneliness is believed to activate the cognitive re-affiliation process, with individuals becoming hypervigilant to social information. That cognitive re-affiliation process may either lead individuals to regulate their behaviour and reconnect successfully or it may lead individuals to become oversensitive to social cues and increase withdrawal behaviour that prolongs loneliness. Therefore, this model highlighted the evolutionary purpose of loneliness, and suggests a dual path of the consequence of feeling lonely.

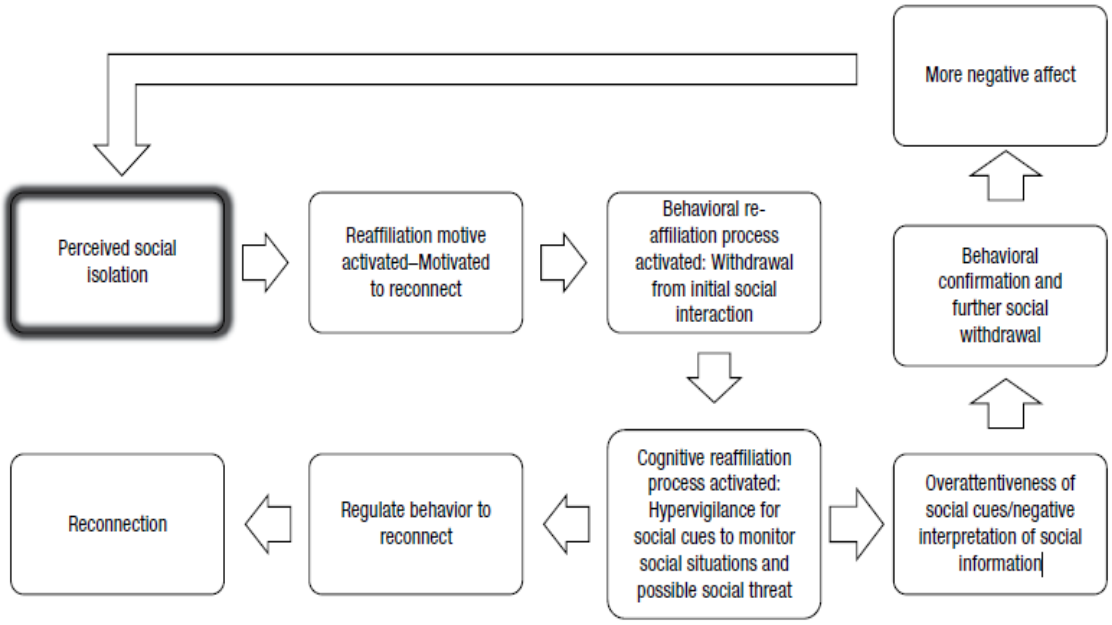


Figure 1.2. The Re-affiliation Model (Qualter et al, 2015).

The cognitive aspects of loneliness model (Spithoven et al., 2017). The Cognitive Aspects of Loneliness Model, showed in Figure 1.3, is inspired by the Social-information Processing model. It highlights the integration account of the cognitive biases and social information processing, accentuating that loneliness is associated with a cognitive bias in all aspects of information processing (Spithoven et al., 2017). The model argues that memory function tends to be one of the core aspects of other negative cognitive biases, and that social skills deficits could be the results of the negative cognitive biases within lonely individuals. Although this model is well defined, not many studies have examined the cognitive biases systematically, or examined the social behaviour and social perceptions of a lonely person. Therefore, the current thesis examines the cognitive biases and behavioural enactment systematically, adding to the literature on social information processing and loneliness, testing this model empirically.

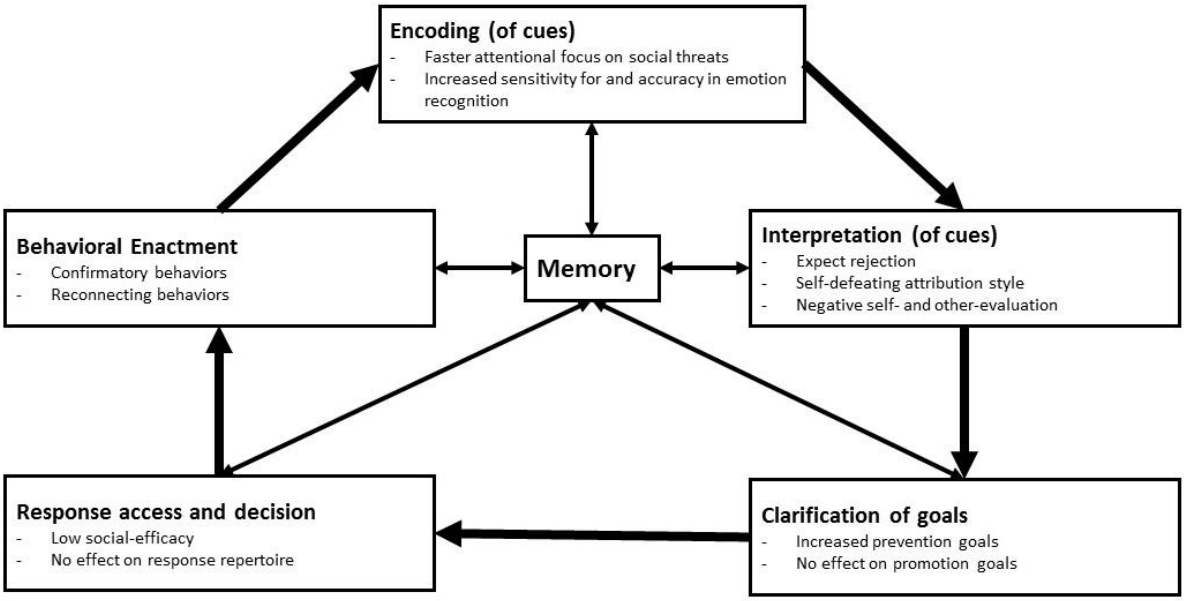


Figure 1.3. The Cognitive Aspects of Loneliness Model (Spithoven, et al., 2017)

Gaps in the Current Literature

According to all three current theoretical models of loneliness, cognitive biases and behavioural withdrawal are two important components of the development and perpetuation of loneliness. Moreover, most of the reviews draw a causal link between cognitive biases and subsequent social behaviour. However, the current theoretical model are incomplete as many gaps in the model were not fully examined. For example, the cognitive biases in lonely people varied at different stages of information processing (attention, memory, and interpretation) (Spithoven, et al., 2017), but the attentional and memory processing of information were not studied in lonely people systematically. In the study of lonely people's social behaviour, the current research did not differentiate the perceptions of one's social behaviour from one's actual social behaviour. Therefore, more details are needed to elaborate the findings in relation to loneliness and cognitive biases, and loneliness and social behaviour.

Therefore, in the current thesis, I summarised the current findings regards loneliness and cognitive biases, loneliness and social behaviour in Figure 1.4, to provide a more thorough overview of the findings regards each stage of processing.

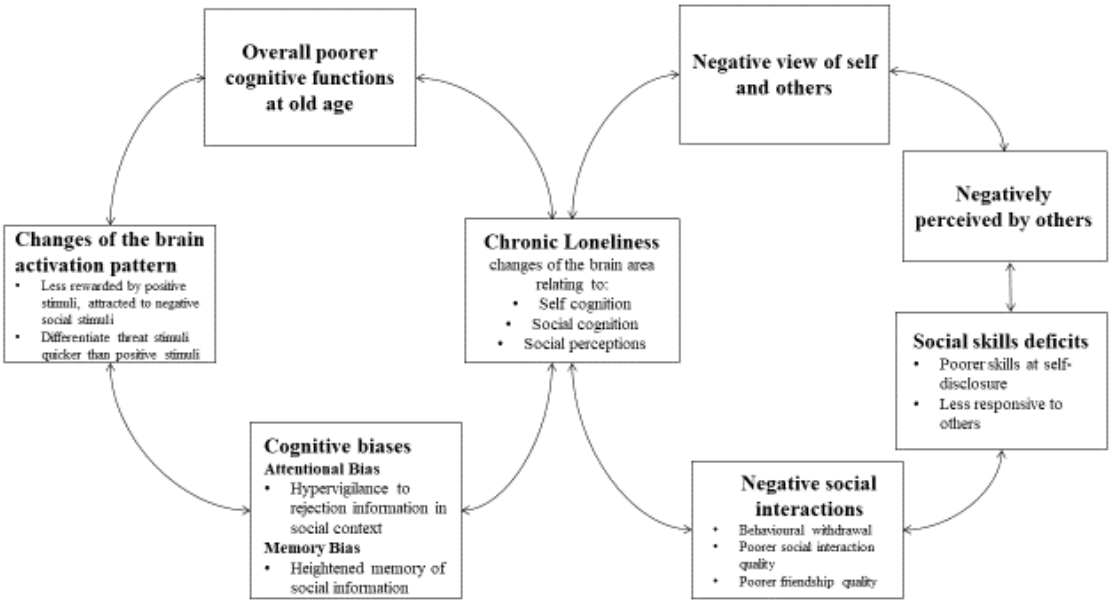


Figure 1.4 The Social-Cognitive model of loneliness based on the findings of current literature.

As it shows in this model, the cognitive path of loneliness is consisted of 1) **cognitive biases**, which include attentional biases towards rejection stimuli in social context and a memory bias for social information. 2) **Changes in the brain activation pattern when processing incoming social information**, with the visual cortex becomes more activated in the processing of socially threatening scenes, but less rewarded by positive stimuli, and the brain differentiates social threat materials quicker than non-socially threatening materials. 3) If the person's feeling of loneliness is persistent, it will drive them to have **poorer cognitive functions at old age**.

At the same time, feeling lonely triggers engagement in a self-fulfilling behavioural and social cognition maladaptation. Loneliness increases the amount of: 1) **perceived and actual negative social interactions**; 2) **impairment of social skills.** The negative social interactions will then promote: 3) **negative appraisals from other people** who interacted with them; 4) those predispositions eventually **alter people's self-view and views of others**, which lead lonely people to perceive their social interaction more negatively and subsequently perpetuate the feelings of loneliness.

Although prior research findings established the link between loneliness and cognitive biases, and between loneliness and social behaviour, the examination is incomplete, as many gaps were left to be filled. For example, although most of the current theoretical models propose that loneliness is associated with certain forms of

cognitive biases, there are no sufficient evidence base for the cognitive biases hypotheses. Specifically, it is unclear whether loneliness is associated with attentional and memory biases towards task-irrelevant emotional information using different cognitive paradigms. Without the systematic study of attentional and memory bias when processing of the task-irrelevant emotional information, it is unlikely to draw conclusions between loneliness and cognitive biases.

Moreover, in the study of social behaviour and social perceptions of lonely people, only a handful of studies used observation method to study real life social behaviour. Moreover, within the studies that explore the social behaviour of lonely people in social interactions, no research has looked at partner's behaviour. Therefore, the models need refining with a new evidence base. Therefore, the current study examines the following research questions and provides the results of loneliness based on the ensuing findings from empirical investigations of these questions:

1. Lonely people demonstrate attentional bias and memory biases in cognitive paradigms.
2. Lonely people demonstrate behavioural withdrawal and maladaptive social cognition in a social interaction.

The current thesis carried out a literature review to summarise the evidence base of the current research findings regarding loneliness and cognitive biases, as well as loneliness and social responses. The literature review will focus on exploring each of the components outlined in the model (Figure 1.4), and point out the gaps need to be filled and how to fill them.

Chapter 2. Literature Review

Literature Search Procedure

A thorough literature search of cognitive biases in lonely people was undertaken by using Web of Knowledge, Psycinfo and Google Scholar electronic databases. The search keywords for the cognitive study included “perceived social isolation and cognition”, “loneliness and cognition”, “loneliness and hypervigilance”, “loneliness and social threat”, “loneliness and implicit attention”, “loneliness and social monitoring”, “loneliness and social neuroscience”, “loneliness and social Stroop”, “loneliness and cognition”, “loneliness and information processing” and “loneliness and attentional bias”. The search keywords for the observation study included “loneliness and social skills”, “loneliness and non-verbal communication”, “loneliness and social monitoring”, “loneliness and social withdrawal” and “loneliness and friendships”.

The criteria for a given paper to be included in the literature review were that it (a) must use quantitative or qualitative methods or be a review paper, (b) written in English, and (c) published from 1980 to December 2017. After filtering repeated and irrelevant papers from this literature search, the total number of core studies that examined cognitive processes and loneliness was 39; for observational research focused on loneliness and communication process, the total number of papers was 76, 7 papers amongst the total number were review papers.

The full summary table of the included literature, including the measurements of loneliness used, the mean and standard deviations of the loneliness level in the paper, and how lonely the sample is in each paper can be seen in Table 2.1.

Evidence of Loneliness and Cognitive Biases

Evidence from functional magnetic resonance imaging (fMRI) and electroencephalogram (EEG) studies. There were a handful of research studies concerning loneliness and brain areas associated with self-concept and social perception. Findings from the Functional magnetic resonance imaging (fMRI) and electroencephalogram (EEG) studies showed that the brain activation patterns of lonely people differed from non-lonely people. Lonely participants in those studies tended to show activation differences in brain regions responsible for social cognition (Lan, et al., 2016), social perspectives (Nakagawa, et al., 2015), and social information processing (Ryota, et al., 2012), compared with non-lonely individuals.

In comparison to non-lonely males, the brains of lonely males showed poorer functional connectivity density in the area related to social cognition (Lan, et al., 2016). Moreover, the brains of lonely individuals tended to have reduced white matter density compared to individuals who were not lonely, indicating that lonely participants could have delayed neural transmission in the area related to self-cognition and social cognition (Nakagawa, et al., 2015). In other words, lonely people may have reduced ability to understand the intentions, feelings, and emotions of others. Finally, the brains of lonely individuals tend to have less gray matter in the left posterior superior temporal sulcus (pSTS)— an area involves in basic social perception, comparing with non-lonely people (Ryota, et al., 2012), suggesting that loneliness may be associated with difficulty in processing of social cues.

More evidence from brain imaging studies showed that the brains of lonely individuals respond to social threat stimuli differently from non-lonely individuals. Cacioppo and colleagues have found that, compared to the brains of non-lonely people, the brains of lonely individuals are less rewarded by pleasant social images but devote more visual attention to negative social stimuli (Cacioppo et al., 2009), are quicker to response to social- versus non-social- threat stimuli (Cacioppo et al., 2015), and show an implicit attentional bias towards the negative social words when completing an emotional Stroop task (Cacioppo et al., 2015). Moreover, by testing resting state fMRI in young adults, lonely individuals showed an increased functional connectivity in the cingulo-opercular network and a reduced function connectivity in the right/superior frontal gyrus, underlying a processing style related to hypervigilance to social threat and a diminished executive function relating to impulse control (Layden et al., 2017).

Sample diversities in these studies. The fMRI and electroencephalogram (EEG) studies provide valid evidence supporting the fact that high lonely individuals tend to have different brain activity in resting state or when processing social cues compared with non-lonely individuals. The results suggest that the brain activation changes in loneliness are prevalent in young adults and old age (for example, Kanai, et al., 2012; Lan et al., 2016; Nakagawa, et al., 2015). For the brain activity in relation to processing of social cues, university students with a higher range of loneliness scores (usually scoring higher than a cut-off point, or using 1 standard deviation above and below to represent high and low loneliness) showed a heightened activation of visual cortex when viewing the image in related to social threat; and differentiate the negative

social stimuli quicker than the positive social stimuli (Cacioppo et al., 2009; Cacioppo Balogh & Cacioppo, 2015; Cacioppo et al., 2015) comparing with non-lonely individuals. However, most of the studies in this domain recruited a small amount of participants within a university student sample, and the designs of these studies have not been applied to a wider range of age groups.

Evidence from using cognitive tasks exploring cognitive biases. Along with the brain imaging studies, more cognitive examination concluded that lonely people have implicit attentional bias towards social threat and explicit memory for social information (Cacioppo et al., 2015). These studies focused on how lonely people's attention and memory systems process negative and positive stimuli, and provide the base of evidence for many contemporary theoretical models of loneliness, for example, the Regulatory Loop (Cacioppo & Hawkley, 2009), the Re-affiliation Model (Qualter et al., 2015), and the Cognitive Aspects of Loneliness Model (Spithoven et al., 2017).

The cognitive paradigms typically use present negative information that is related to one's fear (Williams, Mathews, & MacLeod, 1996), or self-qualities (Conway, Cowan & Bunting, 2001) and investigate how that material temper an individual's performance of a task at hand. Words, texts, sounds, and speech containing emotional meanings, especially ones socially threatening in nature (e.g. humiliate, hate), may disrupt performance on attention and memory tasks requiring strategic processing for lonely individuals more than for their non-lonely counterparts.

An example of the cognitive tasks typically used include the Serial Recall task which involves the visual presentation of a short list of digits followed by an immediate recall of those items in their order of presentation. Participants attempt to memorise the order of visual items while exposed to auditory distractors of different (positive and negative) valence that they were instructed to deliberately ignore. The ensuing goal is to measure the potential disruptive impact of emotionally valent sounds on serial recall performance (Buchner et al., 2004) and whether, in turn, any valence-based disruption is exacerbated or attenuated as a function of the self-reported loneliness of the participant. A serial recall task has been carried out in children by Harris (2014), she found that lonely children aged between 8 to 12 are more susceptible to be distracted by all the conditions with sounds while recalling the digits.

An “emotional variant” of the Stroop task is another typical task measuring individuals’ attentional bias. The emotional Stroop interference refers to the finding that the latencies to name the ink colour of emotional words (e.g. name the ink colour of the word in either red, blue, yellow or green ink) is longer than the latencies for naming the colour of the neutral words. The Emotional Stroop task is used to investigate the interference effects of emotional materials on cognitive processing. It is frequently used to measure attentional bias, especially bias to threats that are related to the issues that particularly concern the participant. So far, only one study were carried out to explore the attentional bias in lonely people using the emotional Stroop task. Cacioppo et al. (2015) carried out an emotional Stroop task with high density EEG study and found that when processing social threat words, lonely individuals differentiate these words quicker than the social positive words.

Loneliness and attentional bias. In support of Cacioppo and Hawkley’s model, Qualter et al. (2013) and Bangee et al. (2014) found that lonely individuals display more visual attention towards social threat stimuli in the early, automatic stage of processing. However, lonely children and adults used different strategies towards these negative social stimuli. Very lonely children found it difficult to disengage from the negative social materials on the playground (Bangee et al, 2014), whereas very lonely young adults initially viewed more of these materials but they tended to disengage from these materials after 2 seconds of viewing (Qualter et al, 2013). Another study conducted by Lodder, Scholte, Goossens, Engels, and Verhagen (2015) examined lonely people’s ability to attend to and decode social information. They found that, in a conversation with an unfamiliar peer, lonely participants spend longer gazing at their conversation partner’s face, which contains subtle social information (Lodder et al, 2015).

Apart from their initial visual attention being drawn to the distress of others, lonely people also lack control of their attention. Cacioppo et al. (2000) carried out a dichotic listening task, which requires the participants to accurately identify the consonant-vowel pair that was presented in either the left or the right ear. Right handed participants were given the instructions to focus on either their left of right ear; or were not given any instructions of which ear to focus before starting the task. Participants should demonstrate a right-ear advantage (identify the consonant vowel pair correctly) when being given the instructions to focus on the right ear, and a left-ear advantage

when been given the instructions to focus on their left ear. Although lonely undergraduate students showed a right ear advantage in identify the consonant vowel pairs when there were no instructions given, or when they were told to focus on the information inputted in their right ear, lonely undergraduate students failed to show a left advantage when they were given the instructions to focus on their left ear, as compared with non-lonely participants. As all participants were right handed and right-ear advantaged, the findings suggest that lonely people struggled when voluntary attention control conflicts with automatic attentional control (Cacioppo et al., 2000). Moreover, Harris (2014) conducted a visual-verbal cross-modal distraction task (a Serial Recall task), using neutral, negative and social words as background speeches, and found that compared with a low lonely group, high lonely children showed poorer serial recall performance in all background speech conditions but not in a quiet condition.

According to the findings of the current literature search, although there are consistent findings relating to loneliness and attentional bias towards socially threatening information, the number of studies is limited, so further studies are needed, particularly with other age groups. For example, the attentional control in a visual-verbal cross modal distraction task was only studied in children, but not adults (Harris, 2014). Moreover, the findings in the area of attentional bias are inconsistent. For example, Lodder et al. (2015) conducted an eye tracker study and found that there was no attentional bias toward social cues between lonely and non-lonely females. However, the materials used in Lodder study were different from the social threat scenes in a playground video used by Bangee et al. (2014) and Qualter et al., (2013). Furthermore, most of the studies examined the attentional biases in lonely individuals used eye tracker technology studying visual attention towards task-relevant social threat, not many has examined how lonely people control their attention towards task-irrelevant information. Thus, more studies need to be conducted in this area using different types of irrelevant threat and positive stimuli, exploring whether individuals with higher scores on loneliness can be differentiated from those scoring low on loneliness in terms of their cognitive biases towards those stimuli.

Loneliness and memory bias. In a systematic review, it was found that lonely adults above the age of 60 tended to have poorer short-term memory, episodic memory, immediate recall, and delayed recall compared with non-lonely adults (Boss,

Kang & Branson, 2015). Empirical studies have demonstrated that loneliness is associated with poorer global memory function in elderly participants and female breast cancer patients. Lonely females with breast cancer also showed impaired memory function in a questionnaire study (Jaremka et al., 2014). Ayalon, Shiovitz-Ezra and Roziner (2016) proposed that there is an important link between memory and the development of loneliness. This study investigated the reciprocal association between loneliness and memory function and found that lower levels of memory functioning predicted higher levels of loneliness over time but not the other way around (Ayalon et al., 2016). Moreover, memory bias also exhibits in social situations: in a study examining individuals' memory of feedbacks after a dyadic social interaction, high lonely participants remembered more negative feedbacks while low lonely individuals remembered more positive feedbacks (Frankel & Prentice-Dunn, 1990).

Although previous studies suggest that feeling socially isolated may trigger a memory bias towards social information (Cacioppo & Hawkley, 2009), very few studies have examined this issue using standard cognitive paradigms. In a social memory task, conducted by Gardner, Pickett, Jefferis, and Knowles (2005), participants were instructed to recall events from a created diary. The diary contained individual positive events, individual negative events, collective social positive vents, collective social negative events, interpersonal social positive events, and interpersonal social negative events. The results showed that lonely participants recalled both positive and negative collective social and interpersonally social events more than non-lonely individuals. Based on those findings, Gardner et al. (2005) argued that lonely individuals tend to have heightened recall of social information in general. However, a study conducted by Harris (2014) replicated the diary study of Gardner et al. (2005) but found no memory bias among lonely children. It is possible that the memory bias develops with age, but to be certain that such a bias is evident among lonely adults, further study of this phenomenon is needed. In this PhD, I examine whether lonely adults between the ages of 18 to 54 show explicit memory bias towards specific task-relevant social information amongst a range of task-irrelevant neutral and valent information.

Emotional recognition (judgement and interpretation of emotional faces). An increasing number of studies have investigated loneliness and emotional recognition, and yielded different results. Gardner et al. (2005) suggest that individuals with fewer friends are more accurate at decoding emotion expressions of faces. In

addition, Vanhalst et al. (2015) showed that individuals with higher levels of loneliness were more accurate at recognising negative emotional faces.

In contrast, Lodder et al. (2015), using a Morph task that required participants to identify facial emotions, found no significant difference between the speed of recognising each emotion in lonely and non-lonely female undergraduate students. However, loneliness showed a small effect on the enhanced recognition accuracy of anger. The findings of the better cognition of anger faces, may be related to the cognitive biases in processing and interpreting the ambiguous scenarios related to social threat stimuli for lonely individuals.

Sample diversities in loneliness and cognitive study. The methods used to explore the relationship between loneliness and cognitive biases includes questionnaires measures, EEG and fMRI studies, eye tracker study or cognitive paradigms. The results of the aforementioned studies demonstrated that loneliness is associated with cognitive biases exhibited in all age groups including children, young adults, adults, and older adults. The mean of loneliness in these studies varied: some studies screen participants and recruit a sample of lonely people using an average mean score of the UCLA loneliness scale (for example, M = 36.67, Ong, Rothstein & Uchino, 2011; M = 32.60, Watson & Nesdale, 2012), but many other studies have found significant results using loneliness as a continuous variable in the analyses. These results regard the association between loneliness and cognitive biases have demonstrated that cognitive biases are shown in individuals scored above the mean loneliness score of the sample. Moreover, cognitive biases have also been exhibited the extreme lonely group (such as individuals scored above 1SD of the mean loneliness score of the sample). For example, children and young adults scoring in the upper quartile on the loneliness scale (for example, Bangee et al., 2014; Qualter et al., 2013), and lonely adolescents who endure loneliness over time (Vanhalst et al., 2015), have been shown to have a cognitive bias with regard to the processing of socially threat information. Such work confirms that a cognitive bias towards social formation exhibits in lonely groups that are categorised by relatively high loneliness scores (at least above the mean scores on the loneliness measure).

Problems with the current cognitive paradigms. Although cognitive biases in lonely individuals were examined by different cognitive paradigms (such as Dichotic Listening task, Serial Recall task, eye tracker study, memory study of diary events,

emotional recognition tasks) using different study materials representing social threat (consonant vowel pairs, words, speeches, diaries made up with social events, images, video clips of real life social scenes, video footage of news, etc), there was a lack of standard measure of the examination of loneliness and cognitive biases towards task-irrelevant emotional stimuli. Amongst the studies examining cognitive biases and loneliness, the aspects of cognitive functions measured were not consistent and the studies were not without limitations. For example, when using eye tracker studies measuring attentional bias towards visual stimuli, the purpose of the task itself is viewing, so it did not have a competition of the attentional resources. The Dichotic Listening task, on the other hand, examined the competition of attentional resources over consonant vowel pairs, but it did not test attentional control of social threat materials. Therefore, more studies are required to examine the association between loneliness and cognitive bias towards social information using standardised cognitive paradigms, such as the Dot Probe task, emotional Stroop task, Dichotic Listening task, Flanker tasks, Directed Forgetting, Part list curing, etc, to explore the cognitive biases in lonely people systematically. Moreover, studies involve cognitive processing hardly used auditory stimuli as study materials. Speech and text plays an important part in everyday life, therefore, more studies are required to examine the auditory processing of social threat material in lonely people.

Longitudinal Studies Looking at the Association between Loneliness and Cognitive Biases

Loneliness is usually transient, based on situations, but when the experience of loneliness is prolonged, loneliness may become chronic (Young, 1982). Situational/transient/state loneliness refers to temporary psychological distress triggered by stressful life events, for example, loss of a spouse or retirement, but usually social relationships can be restored after a short period of time. Chronic/trait loneliness, on the other hand, is a more stable state that results from the inability to restore social relationships over many years. On an affective domain, chronic lonely individuals tend to have lower self-esteem, they are less extraverted, more likely to be depressed, anxious, neurotic and tend to have more external locus of control than transient lonely individuals (Hojat, 1983).

Chronicity of loneliness can be measured. Heinrich and Gullone (2006) summarised that the test-retest correlation of loneliness between two short time points

(6 to 11 weeks) ranges between .71 and .85, whereas the long-term test-retest correlation of loneliness scores between two time points (between 1 to 3 years) is between .38 and .68. The stability of loneliness is also measured in the standard single item measures to some extent because the measures ask about frequency of that experience – always, often, sometimes, not that often and never (for example, Zhong, Chen & Conwell, 2016).

Individuals who suffer from chronic loneliness tend to exhibit more interpersonal difficulties compared with transient lonely individuals. Children experiencing chronic and increasing loneliness also have social skills deficits, suggesting the two are associated (Schinka, van Dulmen, Mata, Bossarte & Swahn, 2013). For adolescents, social skills deficits are a primary contributor for chronic loneliness, the risk of being chronically lonely is linked to troubles with reflections of one's behaviour (Carr & Schellenbach, 1993). Chronically lonely individuals are more likely to suffer from long-term interpersonal deficits compared with transient lonely individuals (Ernst & Cacioppo, 1999; Heinrich & Gullone, 2006). Moreover, transient lonely individuals tend to exhibit better communication of emotional messages when compared with chronically lonely individuals (Gerson & Perlman, 1979). Chronically lonely individuals, in turn, have been rated by their conversation partners as less competent at social situations (Spitzberg & Canary, 1985).

Chronicity of loneliness is often related to a more negative self-concept and maladaptive cognitive processes. For example, Spitzberg and Hurt (1987) propose that the longer one stays lonely, the more self-blaming one will become. Importantly, loneliness is demonstrated to be associated with a negative cognitive process and poorer psychosocial adjustment reciprocally. In a review of cross-sectional studies, it is summarised that loneliness is associated with cognitive biases that promote negative thinking longitudinally, and it was concluded that these negative thoughts also promote prolonged loneliness (Qualter et al., 2013; Qualter et al., 2015). Moreover, chronically lonely adolescents were hypersensitive to social exclusion and hyposensitive to social inclusion (Vanhalst et al., 2015). In the study carried out by Vanhalst et al. (2015), they used vignette depicted social inclusion and social exclusion to examine lonely adolescents' attributional style. The results showed that, chronically lonely adolescents were more likely to attribute social inclusion to external factors and attribute social exclusion to internal factors. Similar findings were reported by Shaver and colleagues

(1985) who suggest that trait lonely individuals tend to make internal and stable attributions, and prefer passive coping styles; in contrast, state lonely individuals tend to attribute loneliness to both internal and external attributions, and prefer to adopt active coping strategies. Loneliness is associated with a reduction of emotional functional skills, and these deficits, in turn, predicted a higher level of loneliness longitudinally (Wols, Scholte & Qualter, 2015).

Furthermore, chronic loneliness is linked to a poorer cognitive function and specifically to memory biases. Lonely adults who report feeling isolated and lonely have been found to have a lower digit symbol coding scores (a measure that access information processing efficiency, or IQ) compared with those who report feeling lonely occasionally (Badcock, et al., 2015). Lower levels of memory functioning precedes higher levels of loneliness 4 years afterward, but not the other way round (Ayalon, Shiovitz-Ezra & Roziner, 2016). However, the number of studies that examine cognitive bias and loneliness longitudinally is small. According to the theoretical models of loneliness, cognitive biases and behavioural maladaptation are interlinked with elevated of feelings of loneliness. Therefore, it is important to examine the longitudinal effects between loneliness and cognitive biases, because the confirmation of whether those biases are linked to loneliness longitudinally may be an important contributor to understand the maintenance and elevation of loneliness. Therefore, my PhD examines cognitive bias, including attention and memory bias systematically at two time points in lonely individuals. Furthermore, I examine whether loneliness impacts on attention and memory for emotional information longitudinally and vice versa.

Loneliness and Social Behaviour

Numerous research studies have found that loneliness is manifested in the behavioural domain (Heinrich & Gullone, 2006). Both lonely children (Coplan et al., 2013) and chronically lonely adults (Ernst & Cacioppo, 1999) are characterised by a withdrawn behavioural profile. Indeed, lonely individuals are often characterised by inhibited sociability (have difficulties in making friends naturally and easily), ineffectiveness in social relationships (see review by Heinrich & Gullone, 2006) and lower social self-efficacy (individuals' subjective rating of confidence to perform well in initiating and maintaining successful social relationships) (Wei et al., 2005). Moreover, a negative association between loneliness and prosocial behaviour has also been found in children (Cassidy & Asher, 1992) and adolescents (Woodhouse, Dykas & Cassidy, 2011).

Loneliness is characterised by a tendency to be socially withdrawn (Cacioppo, Cacioppo & Boomsma, 2014; Qualter et al., 2015). It is widely accepted that lonely individuals tend to display withdrawn and shy behaviour during social interaction (Vanhalst, Luyckx & Goossens, 2014). The tendency for social withdrawal also mediates the effect between rejection sensitivity and loneliness in adolescence, suggesting lonely individuals may avoid being rejected by acting in a socially withdrawn fashion (Watson & Nesdale, 2012). Moreover, social withdrawal at one time point also predicts the increase of loneliness level in two years' time (Boivin, Hymel & Bukowski, 1995). The effect is mediated by social preference and peer victimisation at time point one (Boivin, Hymel & Bukowski, 1995).

The empirical evidence base for the link between loneliness and behavioural withdrawal includes early observational work investigating heterosexual dyadic stranger interaction. The results show that lonely individuals devoted less attention to their partners in social interactions (Jones, Hobbs & Hockenbury, 1982). According to previous research, lonely people tend to adopt a passive and unfriendly communication style (Bell & Daly, 1985), being less responsive to others (Jones et al., 1982) and are less involved in conversations (Bell, 1985; Bell & Daly, 1985). Early research also outlined that lonely people are often upset, easily disappointed, and tend to give in frequently during conflict (Moore, 1974).

Loneliness and interpersonal communication. Lonely people make fewer efforts to self-disclose (Bell & Daly, 1985; Moroń, 2014; Solano, Batten & Parish, 1982), and show a lack of interpersonal intimacy during interaction (Chelune, Sultan & Williams, 1980, Sloan & Solano, 1983). Such behaviour may also mediate or moderate the relationship between loneliness and other interpersonal difficulties. For example, Wei, Russell and Zakalik (2005) found that self-disclosure mediates the relationship between attachment avoidance and loneliness along with subsequent depression. Self-disclosure also moderates the relationship between family conflict and loneliness (Burke, Woszidlo & Segrin, 2012).

Next, in the interaction with an unfamiliar peer, lonely participants display a passive communication pattern. Empirical evidence shows that lonely participants are less talkative and exhibit fewer interruptions and vocal back-channels (no verbal response and no physical cues, such as head nods or uh-huhs indicating vocal attentiveness while the other person is talking) compared with non-lonely participants (Bell, 1985). They are also perceived as less involved and less interpersonally attractive by their peers (Bell, 1985, Jones et al, 1981). In terms of social strategy, lonely individuals often adopt an avoidance strategy instead of an approach strategy in social situations (Nurmi, Katariina & Salmela-Aro, 1997; Nurmi, Toivonen, Salmela-aro & Eronen, 1996), which may contribute to the negative social behaviour they tend to use in social interactions.

Loneliness and partner attention. Moreover, the results of an observational study showed that during a 10-minute social interaction, lonely individuals were less attentive to their partners (Bell, 1985). Attentiveness refers to the ability of individuals to direct their attention towards the interaction (Bell, 1985). Furthermore, one study conducted by Bell and Daly (1985) found that lonely individuals were characterised by their responsiveness to a conversational partner and lack of self-assertiveness (being active in initiating interaction, continuing interaction and ending interaction), tending not to engage in self-disclosure. Their study also revealed that loneliness was positively related to Machiavellianism, which indicates a constrained, unfriendly, and manipulative style of communication (Bell & Daly, 1985). The correlation between loneliness and Machiavellianism was found to be stronger in females (r = .40) than in males (r = .22).

Loneliness and positive social behaviour. However, the findings regarding loneliness and negative social behaviour are not consistent. For example, Vandeputte et al. (2009) did not find that lonely individuals showed a lack of partner attention in the mixed-age dyadic conversation. Loneliness also stimulates pro-social behaviour in children (Qualter & Munn, 2002; Qualter & Munn, 2005). Moreover, after initial encounter with lonely university students in a group interaction, lonely people were seen by other students as more friendly (Christensen & Kashy & 1998).

However, most of the evidence supporting the association between loneliness and positive social behaviour was found when testing the social behaviour in rejection situations or when studying the social behaviour of children. The positive social behaviour in rejection situation may be associated with the desire to meet social needs. According to a social needs perspective, people respond to social exclusion by increasing the desire for reconnection, and attempt building social bonds with new social partners in particular (Maner, DeWall, Schaller & Baumeister, 2007). A study conducted by Maner et al. (2007) found that, after recalling an experience of social exclusion, individuals expressed a greater interest in making new friends and possessed a heightened desire to work with others.

Study of direct observation of children's playground behaviour showed that lonely children tended to display prosocial behaviour towards their peers (Qualter & Munn, 2005), and were nominated by their peers as exhibiting more prosocial behaviour (Qualter & Munn, 2002). In contrast, lonely adolescents reported a lack of both prosocial behaviour and disruptive behaviour (Woodhouse, Dykas & Cassidy, 2011). The results may suggest an alteration of expectations or social strategy through developmental stages, or it may indicate that lonely individuals may display both pro-social and anti-social behaviours in a social situation, for either reaffiliation or avoidance purposes. However, observational research examining both prosocial and withdrawal social behaviour of young adults with a higher level of loneliness is limited.

Limitation of the current research. For most of the studies reported above, participants completed self-reported questionnaires to evaluate their social performances. However, because loneliness is related to a negative evaluation of oneself and their performance within social interaction (Jones, et al, 1982), findings from such self-reported studies may only reflect a subjective communication pattern rather than

the actual communication behaviour of lonely people. Therefore, more studies examining the *actual* social behaviour of lonely people in social occasions are needed. Moreover, those previous studies did not identify the differences between interactions with strangers and interactions with friends. More studies are needed to identify the effect of loneliness on behavioural differences in specific social relationships. Such an examination might help us understand the maintenance of loneliness, and, offer recommendations for intervention.

Sample diversities in these studies. The majority of the studies of loneliness and social behaviour studied young adults or university students. The most common loneliness measures used in the studies examining loneliness and social behaviour is the UCLA Loneliness Scale. Those studies often recruited a sample with a normal loneliness distribution, and the mean scores of loneliness in the studies varied from M = 34.56 to M = 42.70. A few studies also define high and low lonely groups based on scores in the top quarter and bottom quarter on the loneliness scale (Bell, 1985), or based on 1 standard deviation above and below the mean (Jones et al, 1982). However, most of the studies in the area of loneliness and social behaviour only recruited young adults to take part in the study. In a study measuring partner attention of both young and older adults, participants with a higher level of loneliness scores did not show differences in partner attention during social interactions (Vandeputte, et al., 1999). Hence, future studies should examine the social behaviour in a wider range of age groups to reveal the potential differences in social behaviour and the mechanism in relation to the association between loneliness and behavioural alteration. Moreover, the direct observation of loneliness and social behaviour in children found that lonely children display prosocial behaviour in the interaction with their peers (Qualter & Munn, 2005), but research using direct observation methods are limited in adult samples. Hence, more direct observation research is needed to be undertaken when exploring loneliness and prosocial behaviour.

Loneliness and Negative Self-Perception

Along with negative social behaviour, most of the empirical research suggests lonely individuals' perceptions regarding themselves and their social relationships are generally negative. Findings of the association between loneliness and a lower level of self-esteem (a person's sense of self-worth; Rosenberg, 1965) are prominent (for

example, Al Khatib, 2012; Bednar, 2000; Vanhalst et al., 2013), and this negative self-evaluation is also evidenced in high lonely individuals' social relationships (Flett, Hewitt & De Rosa, 1996). Individuals who scored a higher level of loneliness tend to view themselves negatively, view other people negatively, and expect other people to rate them negatively when compared with non-lonely individuals (for example, Christensen & Kashy, 1998; Jones et al, 1981; Jones et al, 1982, Jones et al, 1983, Tsai & Reis, 2009; Wittenberg & Reis, 1986). In addition, individuals who reported a higher level of loneliness perceive their interactions with other people as not being intimate (Jones et al, 1981; Williams & Solano, 1983) and being of poorer quality (Hawkley et al., 2003) compared with those of non-lonely individuals.

Furthermore, many researchers have found that loneliness is associated with a negative anticipation and a negative reflection of their social interactions (Adam et al., 2015). Those negative perceptions also have an impact on their social relationships over time (Hawkley, Preacher & Cacioppo, 2007), such that the initial negativity, and the tendency to self-fulfil this negativity perpetuates negative interactions and moods. Furthermore, Duck, Pond, and Leatham (1994) examined participants' self-evaluation of their social interactions and found that lonely participants hold a negative view about their social interactions across time. Although lonely participants did not differ from non-lonely individuals in their social behaviour beforehand, after being assigned a particular role in a social interaction, they reported feeling more depressed, hostile and anxious compare with non-lonely individuals (Vitkus & Horowitz, 1987).

Moreover, individuals who reported feeling lonely tend to blame themselves for the negative social interactions (Anderson et al., 1994). Specifically, Vanhalst et al. (2015) and Qualter & Munn (2002) have found that chronically lonely adolescents and children tend to attribute social inclusion to external factors, such as luck or coincidence, but attribute social exclusion to internal and stable factors, such as their own sociability and personality. Hence, the findings suggest that lonely people hold an overall negative social cognition covering different domains of social relationships in general.

The findings showing an association between loneliness and negative self-perceptions are consistent in previous literature. The findings were consistent in university student samples where an average loneliness score is used to determine

lonely group membership or when a particular cut-off score (i.e., 1 standard deviation above the mean) are used. Most of the prior literature recruited a relatively large amount of participants, using self-assessment questionnaires. Hence, the results are robust and solid.

Loneliness and social skills. Lonely individuals perceive themselves as less socially competent compared with non-lonely individuals (Spitzberg & Canary, 1985). Segrin and Flora (2000) proposed the Social Skills Deficits model which views loneliness as related to actual social skills deficits rather than perceived social skills deficits. Empirical evidence shows that loneliness is associated with both self-rated (Bell & Gonzalez, 1988; Cacioppo et al., 2006; Carr & Schellenbach, 1993; DiTommasco, Brannen-McMulty, Ross & Burgess, 2003; Jones et al., 1981; Lodder et al., 2016; Segrin & Flora, 2000; Straits-tröster et al., 1994) and other's ratings of lack of social skills (Bell, 1985; Lodder et al., 2016). The effect between social skills and loneliness is also reciprocal: Many studies have demonstrated that deficits in social skills may predict loneliness over time (Schinka, van Dulmen, Mata, Bossarte & Swahn, 2013; Segrin, McNelis & Swiatkowski, 2016).

Moreover, in terms of social strategies, loneliness is associated with using fewer approach social strategies and more avoidance social strategies (Gable, 2006; Nurmi et al., 1996). The avoidance social strategy also predicted loneliness at a later time (Nurmi & Salmela-Aro, 1997), provides support for the social skills deficits view. Furthermore, adopting a social skills training program often successfully reduce individual's loneliness level (for example, Jones et al., 1982; King et al., 1997), suggesting that social skills deficits may contribute to the development of loneliness.

However, many researchers suggest that loneliness is only associated with perceived social skills deficits and anxiety about interactions (Solano & Koester, 1989; Knowles, Lucas, Baumeister, Gardner, 2015) rather than actual social skills deficits. They suggest that lonely individuals are as socially competent as non-lonely individuals, but they perceive their social relationships and their social skills negatively. In support of that account, several researchers argue that some lonely individuals may appear to have social skills deficits but others may only host a negative cognitive discrepancy of their actual skill and ideal skills (please see Lodder et al., 2016, for a discussion). Moreover, although individuals with a higher level of loneliness perceive

themselves and interpret interactions in a negative way, they are not seen more negatively by other people (for example, Christensen & Kashy, 1998; Jones et al., 1981). Therefore, the research examining whether lonely individuals are subjected to perceived or actual social skills deficits still needs exploring, the current thesis will examine this issue.

Other's perspectives. Although lonely individuals expect other people to rate them negatively, the findings of what other people think of lonely people tends to vary. Empirical studies show that other people tend to perceive people who fulfil the lonely stereotype as lacking psychosocial function and preferred them less as a potential friend (Lau & Gruen, 1992; Rotenberg & Kmill, 1999). Lonely individuals are rated more negatively by their peers (Bell, 1985, Tsai & Reis, 2009) and receive less reciprocal friendship nominations from their peers (Williams & Solano, 1983). In addition, lonely children are rated as displaying more disruptive behaviour by their teachers (Chatzigeorgiadou, Pavlidou & Arvanitidou, 2011). Previous studies also suggest that when people are told their interactive partner is lonely, they rate that partner as less attractive, less sincere, and more passive (Lau & Gruen, 1992).

While the aforementioned studies showed that interaction partners sometimes report unfavourable impressions of lonely people, that is not always the case (Solano & Keoster, 1989). Jones, Sansone, and Helm (1983) found that lonely males were rated negatively compared with non-lonely males, but lonely females, on the other hand, were not rated differently by their opposite sex dyadic partner. Other studies also reveal no difference in the perceptions of lonely individual's interactive partner (Jones, Hobbs & Hockenbury, 1982). In fact, lonely individuals were viewed more positively by unacquainted students after a group interaction (Christensen & Kashy, 1998). However, very little research has investigated others' perception of lonely people. Therefore, this thesis will look at the perspective of friends' perceptions of lonely people.

Loneliness and friendships. Forming meaningful relationships with peers is a major development task from late adolescence and early adulthood (Zarrett & Eccles, 2006). Friendship quantity and friendship quality—whether the friendship provides support, intimacy and companionship, etc—have been examined in relation to many internalising problems (Parker et al., 2006). According to empirical analysis, a positive friendship may be beneficial to development, whilst a negative experience of friendship

may increase one's risk of developing mental health problems, such as loneliness and depressive symptoms (Parker et al., 2006). Moreover, the association between shyness, self-esteem, and loneliness is partly mediated by friendship quantity and quality (Vanhalst, et al., 2013), suggesting the friendship quantity and quality may be related to development and maintenance of loneliness.

Previous research has found that lonely individuals have fewer friends, fewer good friends, and see their friends as more dissimilar to them compared with non-lonely people (Bell, 1993). The friendships of lonely people are also characterised by poorer quality in early adulthood (William & Solano, 1983), adolescence (Lodder et al., 2015) and childhood (Qualter & Munn, 2005). Moreover, lonely people tend to have fewer friends compare with non-lonely individuals (Bell, 1993). Poor friendship experiences may contribute to the development of loneliness and intensify one's feelings of loneliness, whereas a good quality of friendship may prevent individuals from developing loneliness. In fact, previous research has outlined that having one close friend can reduce the likelihood of developing loneliness in adulthood (Ernst & Cacioppo, 1999) and childhood (Qualter & Munn, 2005). Therefore, individuals' friendship quantity and quality contributes to their feeling of loneliness. Friendships, in turn, can have both positive and negative influences on the experience of loneliness.

Although dissatisfaction with friendship quantity and quality appears to be a key feature of loneliness (Spithoven et al. 2016), there are actually few studies examining friendship and loneliness in adulthood. Previous studies have mainly focused on the subjective ratings of one's friendships, with some studies examining actual social behaviour and loneliness. Few studies have examined lonely individuals' social behaviour when they interact with their friends. The current study aims to fill this gap in our knowledge.

Loneliness Related Mental Health and Physical Health Deficiency

Loneliness not only leads to negative affect or temporary distress, but chronic loneliness also leads to the deterioration of one's mental and physical health. The link between loneliness and poor mental and physical health has been validated via longitudinal studies in childhood (Qualter, Brown, Munn & Rotenberg, 2010; Harris et al, 2014), adolescence (Hawkley & Cacioppo, 2010; Ernst & Cacioppo, 1999; Heinrich & Gullone, 2006; Qualter et al., 2013), and adulthood (Caccioppo et al., 2006). For

example, empirical research shows a positive correlation between long-term loneliness and depression (Shaver & Brennan, 1991), anxiety (Hojat, 1983), social anxiety (Anderson & Harvey, 1988; Moore & Schultz, 1983), misanthropy, psychoticism, and neuroticism (Hojat, 1982; Hojat, 1983), psychosis (e.g., De Niro, 1995), schizophrenia (DeNiro, 1995; Neeleman & Power, 1994), suicidal ideation (Kirkpatrick-Smith, Rich, Bonner & Jans, 1992) and poor physical health (Cacioppo et al., 2006).

Because loneliness is related to feelings of insecurity in one's social world, lonely individuals tend to exert bodily changes that prepare them to respond to a threatening social world. As a result, feeling lonely triggers a hyperactive stress response, impairing one's long term health (Cacioppo & Hawkley, 2009). Specifically, feeling lonely triggers an increased activation of the hypothalamic pituitary adrenal (HPA) axis which heightens stress response in everyday life and diminishes sleep quality (Cacioppo & Hawkley, 2009). The repeated activation of hypersensitivity to threat in social situations may heighten cognitive load, and drive individuals to suffer from chronic health damage, such as diminished executive functioning, dysregulated brain and physiological systems (Cacioppo & Hawkley, 2009). Studies examining loneliness and health show that lonely individuals tend to become ill easily and tend to pass away at an early age (Cacioppo & Cacioppo, 2014).

Important Correlations of Loneliness

Although the area of loneliness has been researched as a unique topic for many decades, much research confirms that loneliness is significantly interrelated with depression and social anxiety in terms of its origin and its affective, cognitive, and behavioural features.

Loneliness and depression. Loneliness was considered to be an aspect of depression for many decades (Young, 1982). A cross-sectional study examined the relationship between loneliness and age showed that depression is the only factor relating to loneliness at all ages (Victor & Yang, 2012). Previous research outlined that loneliness and depression shared some common features, for example, poor social skills, shyness, and a maladaptive attributional style (Dill & Anderson, 1999). The correlation between loneliness and depression ranges between .40 to .60 in adults (Heinrich & Gullone, 2006) and between . 55 and .62 in adolescents (Mahon et al. 2006). Prolonged loneliness in children at ages 5 to 9 also predicts depression at the age

of 13 (Qualter et al. 2010). Research shows that loneliness and depression are distinct phenomena and loneliness may increase the risk of depression (Cacioppo, Hughes Waite, Hawkley & Thisted, 2006, Heinrich & Gullone, 2006; Weeks et al., 1980). Previous research has indicated that loneliness and depression influence one another reciprocally, and the association is not attributed to the overlap with personality traits (Vanhalst, et al., 2012). Moreover, in a broader perspective, loneliness mainly involves the evaluation of one's social domains of life, while depression involves a wider range of conditions that apply to multiple domains of life (Boivin et al., 1995).

Nevertheless, some findings of the causal effect between the two constructs are inconsistent. Lasgaard et al., (2011) found that depressive symptoms led to more loneliness across time, whereas loneliness did not predict depressive symptoms over time. However, a longitudinal study conducted by Vanhalst et al. (2012) found a strong cross-lagged effect of loneliness on depressive symptoms, but a weaker effect of depressive symptoms on loneliness across time.

According to the previous research, lonely individuals may be affected by depressive symptoms in many domains. Therefore, it is important to control for depressive symptoms for loneliness in the current study, so that any effects of loneliness are shown to be independent of depression.

Loneliness and social anxiety. Empirical investigations have linked loneliness and social anxiety. Social anxiety is characterised by an excessive fear of social situations or negative evaluations from others (American Psychiatric Association, 2013). Anderson and Harvey (1988) found that the correlation between loneliness and social anxiety was .48. Much other research has also found moderate correlations between the two constructs (for example, Jones, et al., 1981, Moore & Scheultz, 1983, Vanhalst, et al., 2015). Sun and Zhou, (2007, cited in Liao, Liu & Zhang., 2014) suggest that social anxiety affects loneliness to a great extent. In their study, loneliness is significantly correlated with Fear of Negative Evaluation (r = .41**), Social Avoidance and Distress (r = .46**) and Social Anxiety (r = .49**). A meta-analysis conducted by Lim and colleagues (2016) found that a higher level of loneliness predicts social anxiety at a later time. On the other hand, a higher level of social anxiety is the only mental health factor that predicts loneliness at a later time.

Loneliness and social anxiety may link strongly because they share an important common cognitive feature, i.e. hypervigilance to social threat (Lim, Rodebaugh, Zyphur & Gleeson, 2016). According to empirical reviews, socially anxious individuals tend to selectively attend to negative social information, which leads to a bias in interpretation and recollection of social events (Mellings & Alden, 2000). These biases, in turn, increase social fears and perpetuate social anxiety (Mellings & Alden, 2000). Such cognitive features are also evidenced in lonely individuals (Cacioppo & Hawkley, 2009). Cacioppo and Hawkley argue that hypervigilance to social threat is a key factor that may contribute to the development and maintenance of loneliness. Moreover, Knowles, Lucas, Baumeister and Gardner (2015) propose that lonely individuals tend to worry excessively about failure which creates anxiety that inhibits lonely individuals from using their skills to process information accurately, resulting in a self-fulfilling prophecy whereby the result is actual failure: lonely individuals constantly monitor their behaviour in situations wherein they are facing social pressure that they feel they have to perform. Such excessive monitoring behaviour that deteriorates social performance is also evidenced in socially anxious individuals (Heerey & Kring, 2007).

Moreover, in the behavioural domain, socially anxious individuals tend to show an elevating self-focused attention in social situations (Clark, 2001) and this pattern of focus impacts individual's social behaviour. Socially anxious people often engage in behaviour indicative of low self-evaluation, behavioural withdrawal, and emotional indifference (Liao, et al., 2014). Likewise, lonely individuals are characterised by lower self-esteem and are socially inhibited (Gullune & Heinrich, 2006), which suggests that lonely individuals may share common behavioural features with socially anxious individuals. For example, socially anxious individuals tend to disclose less in unstructured social occasions (Clark & Wells, 1995) and they are less likely to direct conversations (Pilkonis, 1977); similar pattern of results were found in lonely people, with they also showed a lack of self-disclosure and less influence in conversation diversion (Jones et al., 1982).

Despite the close link between loneliness and social anxiety, studies of loneliness have largely neglected the impact of social anxiety (Lim et al., 2016). Given that loneliness and social anxiety share important common features in the cognitive and behavioural domain, the current study will control the impact of social anxiety in each study.

The Importance of Controlling for Depressive Symptoms and Social Anxiety of Loneliness

Loneliness is interrelated with depression and social anxiety (Anderson & Harvey, 1988), with some researchers arguing that it is important to control for the influence of depression and social anxiety when examining loneliness (Anderson & Harvey, 1988). Several studies have controlled for depressive symptoms and social anxiety when examining the relationship between loneliness and cognitive biases. For example, Qualter et al. (2013) used quadratic regression with depressive symptoms covaried and found that lonely children are hypervigilant to social threat. An emotional recognition study conducted by Vanhalst, Gill and Prinstein (2015) suggested after controlling for depressive symptoms and social anxiety, the effect of loneliness in recognising negative emotional faces became stronger and the effect of loneliness in recognising happy faces disappeared. Other research, in contrast, found no differences in the results of loneliness after controlling for depressive symptoms. Lodder et al. (2015) controlled for depressive symptoms and social anxiety of loneliness when investigating emotional recognition and eye movement in real life social interaction. They found that the results did not vary after controlling for the two measures in two different methods of analyses (a regression analysis and an Actor Partner Interdependence Model in structural equational modelling).

Moreover, depressive symptoms and social anxiety are subject to unique cognitive bias and behavioural manifestations respectively. According to empirical reviews, information processing bias contributes to the etiology and maintenance of depression (Gotlib & Joormann, 2010) and the maintenance of social anxiety (Hirsch & Clark, 2004). Hence, the current thesis will examine whether depressive symptoms and social anxiety have an impact on the relationships between loneliness and cognitive biases and loneliness and behavioural alterations.

The Purposes of Current Study

According to the literature review, although loneliness and cognitive biases, loneliness and social behaviours has been studied, there are some gaps left to be filled. The gaps that will be tested in the current thesis were outlined in red in Figure 2.1. The aim of the study is to 1) explore whether lonely university students are associated with

specific attention and memory biases toward social threat information and 2) explore the social behaviour and perceptions of lonely undergraduate females and their friends.

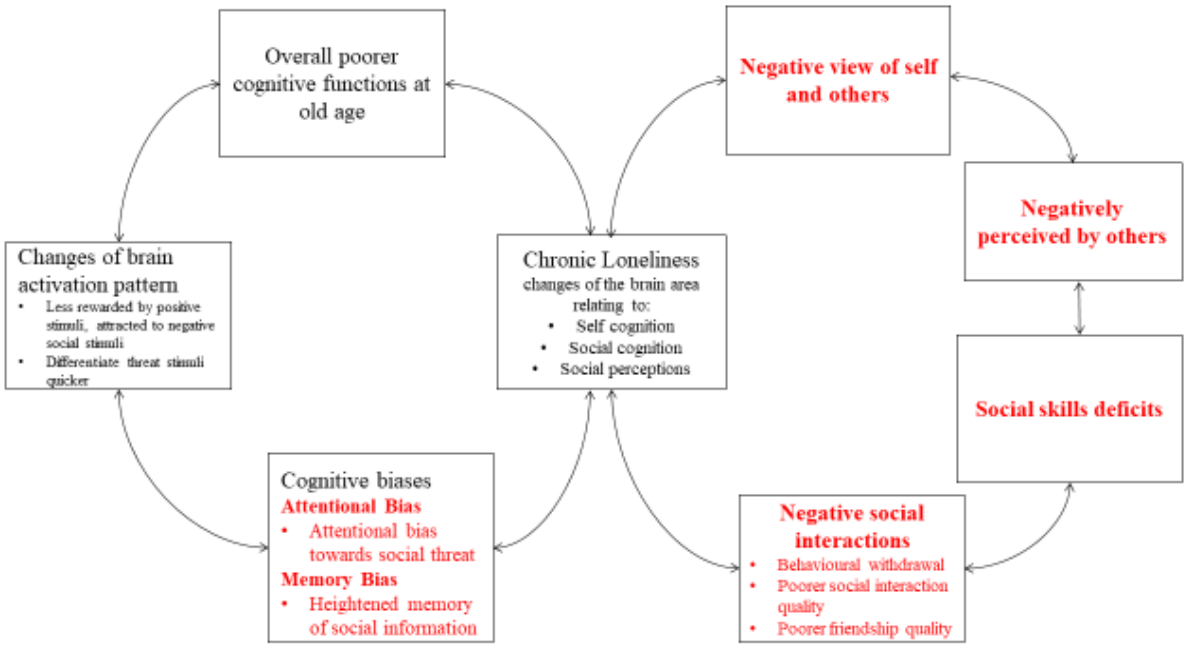


Figure 2.1 The Social-Cognitive Model in the current thesis. Note: The areas highlighted in red are the areas need to be tested in the current thesis.

Study 1. Cognitive Bias in Lonely People: Cross-sectional and Longitudinal Examination

So far, most of the research investigating loneliness and cognitive bias in social information processing has found that lonely individuals have implicit attentional bias towards social threat and memory bias towards social information. However, not many studies have examined the cognitive biases to irrelevant valent information when engaging in a focal task in lonely people. Study 1 uses three cognitive paradigms to examine whether lonely individuals show attention or memory biases to irrelevant emotional information. Moreover, current research of loneliness and cognitive biases mainly focused on lonely people's cognitive biases towards Social Threat information. Not many have studied the cognitive biases towards Social Positive, Physical Threat and Physical Positive information. The current thesis filled this gap by studying the cognitive biases in lonely individuals towards all the aforementioned word categories, in comparison with Neutral information. Furthermore, a longitudinal design is applied

to examine the bidirectional effects between loneliness and cognitive bias across two time points. The aims of the cognitive study were to examine whether:

1) Lonely people have implicit attentional bias towards social threat.
2) Lonely people have memory bias towards social information.
3) Loneliness contributes to attentional bias and memory bias towards social information longitudinally.
4) Attentional bias and memory bias towards social information could contribute to elevated loneliness level longitudinally.

Analysis Plan

Repeated Measures and Mixed ANOVA. In this study, the repeated measures and the mixed analysis of variance (ANOVAs) will be used to explore the main effects of the manipulations of the independent variables on task performance. In the serial recall task, the impact of different irrelevant sounds on task performance is examined. A 6 (sound conditions) × 8 (serial positions) repeated measures ANOVA will be run with sound conditions and serial positions as independent variables, and performance of serial recall as dependent variable. In the emotional stroop task, a repeated measures ANOVA will be carried out to explore the effect of word content (within-subject variable) on the reaction time taken to colour name each word in each category. In the directed forgetting task, a 5 (Word Category) × 2 (Instruction) mixed ANOVA will be carried out to examine whether word category and instructions have an impact on recall performance.

Linear and Curvilinear regression. For the analysis of the impact of loneliness on the cognitive task results, loneliness will be used as a continuous variable in the Linear and Curvilinear regression analysis. This is because previous research has shown that, across development, there appears to be a small subgroup of people who are at a high risk of developing prolonged loneliness (Qualter et al., 2015). This group of individuals are not identified in studies focussing on the mean level of loneliness (Qualter et al., 2015). Therefore, this study determined whether there was a linear or curvilinear relationship between loneliness and the measures of cognitive biases, and shed light on the patterns and directions of the results for individuals classified as very high lonely. In this thesis, loneliness will be used as an independent variable to explore the impact of loneliness on the effects typically observed for the cognitive studies.

Cross-lagged panel model. For the longitudinal study, the linkage between loneliness scores and cognitive task results at the two time points will be examined by the cross-lagged panel model. By using this analysis, the variables could be compared not only within each time point but also across the two time points. Moreover, the analysis enabled the comparison of, not only the impact of level of loneliness on the performance of the cognitive tasks, but also the impact of the performance of cognitive tasks on levels of loneliness.

Study 2. Observational Study: Loneliness and Social Interactions in Female Friendship Dyads

Previous research posits that lonely people tend to disaffiliate with others. They are more behaviourally withdrawn and perceive themselves and their social world negatively. Study Two uses an observational method to examine the behavioural profile of lonely people within female friendship dyads. Using filmed social interactions and post interaction questionnaires with regards to friendship quality and interaction quality, university student friendship dyads' interaction behaviour were observed, and their post interaction questionnaires were subjected to analyses. The hypotheses for this study are as follows:

1) Lonely individuals will display negative communication pattern and show withdraw behaviour in the interaction with their friends.
2) Friends of lonely individuals will show negative behaviour towards lonely females.
3) Lonely individuals will hold a negative view of themselves, their friends, and their social relationships in general.
4) Friends of lonely individuals will hold a negative view of lonely people and rate their friendship less fulfilling.

Analysis Plan

Actor–Partner interdependence model (APIM). The current observation study uses actor-partner interdependence model to analyse the behavioural and questionnaire data from the study). Traditional analyses (e.g. ANOVA, regression) assume that each participant is independent, and the outcome of one person will not have an impact on the outcome of another person. However, in the dyadic interactive relationship, one person's behaviour is affected by the the other person's behaviour (Cook & Kenny,

2005). Therefore, in the design of the current study, wherein participants are interacting with one of their friends, using the Actor-partner interdependent model will be effective in exploring the interdependent relationship of the friendship dyads.

Study 3. The impact of Depressive Symptoms and Social Anxiety

According to previous research, loneliness shares many common cognitive and behavioural features with depressive symptoms and social anxiety. Hence, Study 3 will examine whether the results of Study 1 and 2 would be different if the loneliness scores were controlled for depressive symptoms and social anxiety. This study will discuss the importance of controlling for depressive symptoms and social anxiety when studying the association between loneliness and cognitive biases.

Recruitment Procedure

Study one: cognitive study. Participants for the cognitive study were recruited from student and staff populations at the University of Central Lancashire and from the student population at Cardiff Metropolitan University. At both university locations, Flyers and Email Newsletters were distributed across campuses. The recruitment advertisement and the email sent to all students and staff are shown in Appendix 14 and Appendix 15. The majority of students participating in the study were undergraduate and postgraduate Psychology students but recruitment occurred from all departments across the universities. Students contacted the researcher via email to sign up for the study. All students recruited self-reported fulfilling the requirement of being a native English speaker and reported normal or corrected-to-normal vision and normal hearing. Participants enrolled on Psychology courses were offered 6 course credits and a £5 Amazon voucher for completing the study while non-psychology participants were offered a £5 Amazon voucher only. All students were invited to participate in a prize draw to win £50 worth shopping voucher. All participants were told at the start of the study that they would be contacted again in a few months' time. All students completed the study at Time 1 were contacted after 10 months' time. The researcher emailed the procedure of the tasks and scheduled a time with the participant if they said they would like to take part. The sample email for contacting students at Time 2 is included in Appendix 18. Completing the study rewarded them with 6 course credits and a £5 Amazon Voucher.

Study two: observation study. Students from the University of Central Lancashire were recruited via Flyers and campus-wide email announcement (Appendix 16 and Appendix 17). The weekly email newsletter was sent to all staff and students across campus. The advertisement briefly explained that the study involved social interaction with a friend while being filmed. Only female students were recruited. Students would also need to bring a female friend to take part in the study. Students contacted the researcher via email if they wanted to participate. The students were rewarded with 6 course credits and a £5 Amazon voucher when they completed the study.

Table 2.1. *Summary of the findings of the studies considered in the literature review*

Title	Author(s)	Loneliness measure	Types of study	Age	Prevalence of loneliness	Number of Participants	Results
Functional magnetic resonance imaging (fMRI) and electroencephalogram (EEG) studies							
Loneliness and implicit attention to social threat: A high-performance electrical neuroimaging study	Cacioppo et al., (2015)	Revised UCLA scale, 1996	Neuroscience - viewing images while measuring brain activation	Adults, Mean=24.05 (range=18-44)	Lonely: N=10 (M = 51.80; SD = 6.61, range: 43–60); non-lonely: N=9 (M = 31.67, SD = 5.43; range: 23–40).	19	Lonely individuals differentiate the social threat images quicker than the non-social threat images compare with non-lonely individuals.
Functional connectivity density mapping of depressive symptoms and loneliness in non-demented elderly male	Lan et al., (2016)	UCLA, version 3; Russell, 1996	Neuroscience -fMRI scan	Han Chinese male, Over 65	Loneliness Mean=29.6 (SD=8.7)	85	Loneliness is associated with functional connectivity density (FCD) changes in the brain region associated with social cognition. Depressive symptoms and loneliness are associated with FCD changes in different brain regions in non-demented elderly males.

White matter structures associated with loneliness in young adults	Nakagawa et al., (2015)	UCLA Loneliness Scale, version 3, 1996	Neuroscience -white matter-MRI	M=20.2, SD=1.5, Range 18-27	Loneliness Mean=37, SD=9.2	776	Loneliness is correlated with a white matter density reduction in the brain area related to self and social cognition, as well as the area related to empathy and self-efficacy.
Brain structure links loneliness to social perception	Ryota et al., (2012)	UCLA Loneliness Scale, Version 3, 1996	Neuroscience -multiple studies	Five studies, age range from 18-39	The scatterplot between loneliness and gray matter volumes showed a normal distribution of loneliness scores, with the majority of people scoring between 40 and 50 on the UCLA Loneliness Scale, 1996, score range between 20-80.	study 1: 108; study 2:22; study 3:45; study 4: 61; study 5: 95	Lonely individuals have less grey matter in the area related to basic social perception.
In the eye of the beholder: Individual differences in perceived social isolation predict regional brain	Cacioppo et al., (2009)	UCLA Loneliness Scale, 1996	functional magnetic resonance imaging (fMRI)	Undergraduat e student	High and low lonely individuals are defined by scoring on the UCLA loneliness scale 1 SD above	23 females	Lonely individuals are less rewarded by pleasant social stimuli but showed more activation in visual cortex when viewing

activation to social stimuli					and below the mean		negative social stimuli.
Implicit attention to negative social, in contrast to nonsocial, words in the Stroop task differs between individuals high and low in loneliness: Evidence from event- related brain microstates	Cacioppo, Balogh & Cacioppo (2015)	UCLA Loneliness Scale version 3, 1996	social Stroop task and EEG study	M=23.59	38 participants are classified as high lonely (M=48,SD=6.68); 32 participants are classified as low lonely, (M=31.91, SD=5.08)	70	The negative social stimuli were differentiated quicker from negative non-social stimuli in the lonely than non-lonely brains.
Perceived social isolation is associated with altered functional connectivity in neural networks associated with tonic alertness and executive control	Layden et al., (2017)	Revised UCLA Loneliness Scale, 1996	fMRI	M=23.7, range: 20-29	Loneliness M=40, SD=8.1, loneliness is treated as a continuous variable in the current study	55	Loneliness is associated with a reduced functional connection in the brain region related to hypervigilance to social threat and diminished impulse control.
Cognitive functions in general							
Loneliness and cognitive function in the older adult: a systematic review	Boss, Kang & Branson, (2015)	The majority of authors used only one or two direct questions (whether they feel lonely, left out, isolated) in	Review article	mean age above 60 years		10 studies in total	Loneliness is negatively associated with cognitive function in old age, the findings are particularly robust in the domains of global

		the form of yes/no or Likert style.					cognitive function, IQ, processing speed, immediate recall and delayed recall.
Association of depression and loneliness with specific cognitive performance in non-demented elderly males	Tzang et al., (2015)	UCLA version 3, 1996;	Cognitive functions were measured by: Cognitive Abilities Screening Instrument Chinese version and the Wechsler Digit Span Task.	M=80.2, SD=4.5. range =65-98	Loneliness is a continuous variable	189	Loneliness is negatively correlated with cognitive functions including Attention, Orientation, Abstraction and judgement, and List generating fluency. Depression is specifically negatively correlated with orientation.
Perceived social isolation and cognition	Cacioppo & Hawkley, (2009)	n/a	Review article				Loneliness is related to a decreased executive functioning, negative social cognition, hypervigilance to social threat and a self-fulfilling negative behavioural confirmation process.

A model of loneliness in older adults	Fees, Martin & Poon, (1999)	Loneliness was measured with 3 indicators: 1. Feeling lonely; 2. Feeling very alone; 3. Lonely dissatisfaction	Questionnaires	M=64.96, SD=2.80, range: 60-106	Loneliness M=5.28, SD=1.91	208	Cognitive functioning does not affect perceived loneliness. Feeling lonely decreases one's subjective ratings of health.
Loneliness accentuates age differences in cardiovascular responses to social evaluative threat	Ong, Rothstein & Uchino, (2011)	Revised UCLA Loneliness Scale (Russell, Peplau, & Cutrona, 1980).	Questionnaires, speech induce social evaluation	Young M=19.64; old M=71.73	Young Loneliness M=32.60, SD=7.76; Old Loneliness M=32.52, SD=7.39	91 young (18 –30 years) and 91 older (65– 80 years) adults	Loneliness is associated with a greater blood pressure to social evaluative stress than non-lonely individuals.
Loneliness in psychotic disorders and its association with cognitive function and symptom profile	Badcock, et al., (2015)	Item 10.19 of the survey, adapted from the Australian Quality of Life Survey: "In the last 12 months have you felt lonely?" Responses were made using a 4-point scale, reflecting increasing feelings of loneliness	(1) Digit Symbol Coding Test (DSCT), measuring information processing efficiency; (2)National Adult Reading Test-Revised, measuring IQ	Mean age= 38.19, (SD= 11.03). 42.9% were aged 18–34 and 57.1% were aged 35–64	79.9%, reported feeling lonely in the past 12 months (1) I have plenty of friends, and have not felt lonely — 20.1%; (2) Although I have friends, I have been lonely occasionally — 31.9%; (3) I have some friends, but have been lonely for company—	1603	Participants feeling socially isolated/lonely for company had significantly lower digit symbol coding (measuring IQ) scores than those who only felt lonely occasionally. Unexpectedly, participants who reported not feeling lonely had the lowest digit symbol coding scores.

					24.8%; and (4) I have felt socially isolated and lonely — 23.2%.		
Negative social cognition							
Feelings of loneliness among adults with mental disorder	Meltzer; et al., (2012)	One question from the 8-item Social functioning questionnaire	Interviews and self-rated questionnaires	Adults		7461	Increased social support and social opportunities are less beneficial than addressing maladaptive social cognition as an intervention for loneliness.
Rejection sensitivity, social withdrawal, and loneliness in young adults	Watson & Nesdale, (2012)	Revised UCLA Loneliness Scale (RULS; Russell, Peplau, & Cutrona, 1980).	Questionnaires	M=23.2, *SD* = 7.4.	Loneliness M=36.67, SD=10.71	188	Rejection sensitivity is a significant predictor of loneliness. The effect of rejection sensitivity on loneliness is mediated by social withdrawal in order to avoid social rejection.
Cognitive and situational precipitants of loneliness among patients with cancer: a qualitative analysis	Adams et al., (2016)	Participants then were asked to describe any experiences of loneliness	Qualitative interview	Cancer patients Mean age=62.6, SD=11.9, range: 43-77	Several participants said they felt lonely during periods of physical isolation.	15	Cancer patients reported feeling lonely when they had negative thoughts about their social situations.

		since their cancer diagnosis.					
Loneliness, clinical import and interventions	Cacioppo et al., (2015)		meta-analysis				There is a significant relationship between loneliness and maladaptive cognition.
Why do the lonely stay lonely? Chronically lonely adolescents' attributions and emotions in situations of social inclusion and exclusion	Vanhalst., et al. (2015)	Loneliness and Aloneness Scale for Children and Adolescents (LACA; Marcoen, Goossens, & Caes, 1987)	Questionnaires and Vignettes, 4 wave longitudinal study	M=15.43, wave 1, M=22.82	consistently low (*low-stable trajectory*): 47% of the sample; consistently moderate (*moderate-stable trajectory)*, 27% of the sample; high loneliness scores that decreased over time (*high-decreasing trajectory)*, 9% of the sample; increasing trend over time (*moderate-increasing trajectory)* 14% of the sample;	730	Chronically lonely adolescents were characterized by hypersensitivity to social exclusion (i.e., higher levels of negative emotions) and hyposensitivity to social inclusion.

					chronically high trajectory, 22 individuals (3% of the sample)		
A meta-analysis of interventions to reduce loneliness	Masi et al., (2011)		Qualitative reviews				The most successful interventions for loneliness is addressing maladaptive social cognition.
It is all in their mind: A review on information processing bias in lonely individuals	Spithoven, Bijttebier & Goossens (2017)		Review				Lonely people are characterised by cognitive biases specifically associated with ambiguous situations and for social context.
Attentional Bias							
Loneliness and attention to social threat in young adults: Findings from an eye tracker study	Bangee et al., (2014)	Revised UCLA Loneliness Scale, 1996	eye tracker study-free viewing of playground video	Mean=18.22, SD=.46, Range 17-19	Upper quartile range of loneliness score is defined as high lonely	85	Very lonely young adults showed an initial vigilance towards social threat stimuli, but quickly avoided these stimuli after 2 seconds.
Investigating hypervigilance for social threat of lonely children	Qualter et al., (2013)	Study 1: Four-item "pure" measure derived	Questionnaires, vignettes, eye tracker study-free	between 8 and 12	Study 1: low medium lonely group: scores below 7 (135	Study 1: 185 Study 2:248	Study 1: Lonely children showed greater attribution to hostile intentions,

		from Asher et al. (1984). Study 2 & 3: 12-item Peer subscale of the Loneliness and Aloneness Scale for Children and Adolescents (LACA: Marcoen et al. 1987)	viewing of playground video		participants) and high lonely group (50 participants) with scores above 7. The score of 7 defines the upper quartile (25%) of the loneliness scores. Study 2: low-medium lonely group: mean loneliness scores below or equal to 3 (219 participants) and high lonely group (29 participants) with scores above 3. The score of 3 defines the upper quartile of the loneliness scores. Study 3: children scored of the upper quartile of loneliness scores are defined as high lonely	Study 3: 140	retaliation and hostility to ambiguously intended social exclusions compare with hostility intended social exclusions. Study 2: Loneliness is positively associated with rejection-sensitivity scores. Study 3: The eye tracker study also showed that very lonely children showed difficulties to disengage from social threat stimuli. The

							results together showed that very lonely children are hypervigilant to social threat.
Lonely traits and concomitant physiological processes: the MacArthur social neuroscience studies	Cacioppo et al., (2000)	UCLA loneliness scale, 1980	Dichotic listening Task	Undergraduate student	Three groups, top, middle and bottom quintile of the loneliness score, Upper quintile-Lonely group; Middle-normal group; Bottom quintile-social embedded group.	5% of 2632 participants were invited for more intensive study	Lonely people showed an attentional deficit in attentional control when there was a conflict between the automatic and voluntary attentional processes.
Loneliness and health: physiological and cognitive mechanisms in adulthood and childhood	Harris (2014)	R-UCLA loneliness scale (Russell et al., 1980).	Serial recall task, social memory task	Children between 11 and 12	High lonely- M=2.69 low lonely- M=1.35	55	High lonely children are more distracted by the irrelevant speech when performing an auditory distraction task, but they did not show a memory deficit in recalling social events.
Loneliness and the social monitoring system: emotion recognition and eye gaze in a real-life conversation	Lodder et al., (2015)	UCLA Loneliness Scale version 3, 1996	emotion recognition task; eye gaze in conversation study	college students (study 1: 17-24; study 2: 17-27)	Loneliness M=31.98, SD=8.41	170 & 130	Lonely individuals did not show signs of increased social monitoring. However, loneliness is related to increased social

							monitoring in real-life social interactions with a peer.
Loneliness and hypervigilance to social cues in females: an eye-tracking study	Lodder et al., (2015)	UCLA Loneliness Scale version 3, 1996	emotional recognition and eye tracking study	college students, M= 19.88, SD = 1.41	25 nonlonely participants (scoring within the 13% lowest scores within the current sample) and 25 lonely participants (scoring within the 10% highest scores within the current sample)	50	There were no significant differences of visual attention towards social cues between lonely and non-lonely individuals.
Examining the visual processing patterns of lonely adults	Bangee & Qualter (2018)	UCLA Loneliness scale, Russell, 1996)	Eye-tracking study, emotional faces and pictures were presented	University students, M= 20 years and 2 months (SD = 3 months) , range: 18-30	Loneliness range 24-73. A loneliness score above 60 were classes as the lonely group	43	Lonely adults did not show a hypervigilance to social threat, but they show a specific attentional bias towards social information in social contexts.
Memory bias							
A cross-lagged model of the reciprocal associations of loneliness and memory functioning	Ayalon, Shiovitz-Ezra & Roziner (2016)	Short version (3 items) Revised UCLA; score range from 1-3.	Memory tasks- 1.immediate word recall task; 2.delayed	over 50, mean=65.96	M=1.38 (year 2004); M=1.43 (year 2008); M=1.44 (year 2012)	1225	Lower levels of memory functioning precedes higher levels of loneliness 4 years afterward but not the other way round.

			verbal recall task				
On the outside looking in: loneliness and social monitoring	Gardner et al. (2005)	R-UCLA loneliness scale (Russell et al., 1980)	Social memory task (diary study)	undergraduate student	Loneliness is a continuous variable	Study 1: 95 Study 2: 74	A higher level of loneliness is associated with an increased social memory of both positive and negative social events.
Cognitive problems among breast cancer survivors: loneliness enhances risk	Jaremka, L. M. et al. (2014)	UCLA loneliness scale; 8-item New York Univeristy Loneliness scale	Self-reported questionnaires,neuropsychological continuous performance test (Concentration)	Study 1: M=51.58; Study 2a: M=56.94; aStudy 2b: M=53.16	Loneliness is a continuous variable	Study 1: 200; Study 2a: 278; Study 3: 43	Lonelier women reported more concentration and memory problems than less lonely women. Study 2 showed that lonelier women experienced more concentration problems than the less lonely counterparts.
Loneliness and the processing of self-relevant information	Frankel & Prentice-Dunn, (1990)	Revised UCLA loneliness scale, 1980	dyadic social interaction, videotaped performance feedback, recognition test of the videotaped feedback	Male college students	Loneliness M=35.7, SD=8.68. 144 participants were designated as either high lonely (scored one standard deviation above the mean) or low lonely (scored	144	High lonely males rated themselves more negatively than low lonely males. High- and low-lonely participants remembered negative and positive information more accurately respectively.

					one standard deviation below the mean)		
Recognition of emotional cues							
Getting a cue: the need to belong and enhances sensitivity to social cues.	Pickett, Gardner & Knowles (2004)	Need to belong scale (Leary et al. 2001)	Vocal Stroop task and face recognition;	Undergraduate students, M=18.71		98	Individual differences in belonging needs were associated with decoding verbal and nonverbal social cues more accurately.
Lonely adolescents exhibit heightened sensitivity for facial cues of emotion	Vanhalst, Gibb & Prinstein (2015)	A 5-item adaptation of the Loneliness and Social Dissatisfaction Questionnaire (LSDQ, Cassidy & Asher, 1992)	emotion recognition task	Adolescents, Mage = 13.65 years, SD =0.57	Loneliness is a continuous variable	170	Loneliness is associated with heightened sensitivity to happy, sad, and fear faces. When controlling for depressive symptoms and social anxiety, loneliness is still significantly associated with heightened sensitivity to sad and fear faces.
Loneliness and social behaviour							
Rejection sensitivity, social withdrawal, and loneliness in young adults	Watson & Nesdale, (2012)	Revised UCLA Loneliness Scale (1980).	Questionnaires	*M*=23.2, *SD* = 7.4.	Loneliness M=36.67, SD=10.71	188	Rejection sensitivity is a significant predictor of loneliness. The effect of rejection

							sensitivity on loneliness is mediated by social withdrawal in order to avoid social rejection.
Loneliness and social skill deficits	Jones, Hobbs & Hockenbury (1982)	UCLA Loneliness Scale, (Russell et al, 1978)	Dyadic interaction and questionnaires	18-25	**Study 1:** Loneliness Median Male=38.0, Female=37.5. 4 groups were created based on median split of loneliness scores, high-lonely men (n = 12), high-lonely women (n = 12), low-lonely men (n = 12), and low-lonely women (n = 12). **Study 2:** High lonely male were selected based on 1.5 SD above the normative mean. Female participants were selected on the basis of medium level loneliness	Study 1: 48 Study2: 18 high lonely males	Study 1 showed that high-lonely individuals give less partner attention during a conversation compare with low-lonely individuals. Study 2 showed that after increasing partner attention, there is a significant reduction of loneliness level and negative self-perceptions in high lonely males.

					scores (within ±1 SD from the normative mean).		
Lonely hearts: psychological perspectives on loneliness	Ernst & Cacioppo, (1999)		Review article				Chronically lonely people are characterised by a high negative affectivity, a withdrawn behavioural profile and are less trusting of self and others.
The roles of social withdrawal, peer rejection, and victimization by peers in predicting loneliness and depressed mood in childhood	Boivin, Hymel & Bukowski (1995)	Loneliness and Social Dissatisfaction Questionnaire, Wheeler & Asher, 1985	Self-reported questionnaire	M=130 months (9-12 years)	Longitudinal study, loneliness is a continuous variable in regression analyses	567	Social withdrawal at one time point predicts the increase of loneliness level in two years' time, the effect is mediated by social preference and peer victimisation at time point one.
The friendships and play partners of lonely children	Qualter & Munn (2005)	Parent and Peer Related Loneliness Questionnaire (Marcoen & Brumagne, 1985)	Questionnaires, Observation study	M=76 months, age between 5 to 8 years	4 clusters defined: Cluster A: Not lonely well accepted, 58.5% of the sample. Cluster B: Not lonely, not accepted, 9.4%. Cluster C: Lonely, not	409	Direct observation study showed that lonely children display prosocial acts, and lonely children tend to have positive interactions with other children.

					accepted, 9.5%. Cluster D: Lonely, well accepted: 22.6%		
The separateness of social and emotional loneliness in childhood	Qualter & Munn (2002)	Parent and Peer Related Loneliness Questionnaire (Marcoen & Brumagne, 1985)	Questionnaires, Observation study	4–9-year-old children	4 clusters defined: Cluster A: Not lonely well accepted, 58.5%, N=374. Cluster B: Not lonely, not accepted, 9.4%, N=60. Cluster C: Lonely, not accepted, 9.5%, N=61. Cluster D: Lonely, well accepted: 22.6%, N=145	640	Some lonely children demonstrate lack of interest in other people and did not initiate interactions. Peers nominate lonely children as exhibiting more prosocial behaviour.
Alone is a crowd: Social motivations, social withdrawal, and socioemotional functioning in later childhood	Coplan, Rose-Krasnor, Weeks & Kingsbury (2013)	Loneliness and Social Dissatisfaction Questionnaire (Asher & Wheeler, 1985, range=1-5	Mother rated and Self-reported questionnaire, observation study	*M*age =10.16 years, *SD* =0.95), age 9 -12 years	Loneliness M=1.95, SD=0.64	367	Loneliness is associated with more observed social withdrawal, and self-reported solitary activities outside school.
Loneliness and patterns of self-disclosure	Solano, Batten & Parish (1982)	UCLA Loneliness Scale (Russell, Peplau, & Ferguson, 1978)	Questionnaires and dyadic conversation	undergraduates	Study 1: Male Loneliness M=42.7, Female M=38.4 Study 2: lonely and non-lonely	**Study 1:** 37 males and 38 females; Correlation analyses	Lonely participants have both self-reported and actual differences in self-disclosure pattern from non-lonely

					person are those scored 1 standard deviation above and within or below the mean, (M=37.1, SD = 8.6)	**Study 2:** 24 lonely (M=51.2) and 23 nonlonely participants (M=30.3) paired with non-lonely partners (M=30.3; M=39.5)	participants. Lonely individuals had a low initial level of intimacy in conversation with opposite sex partners.
Loneliness, self-disclosure, and interpersonal effectiveness	Chelune, Sultan, & Williams, (1980)	UCLA Loneliness Scale, 1978	Questionnaires and dyadic conversation	female undergraduates, 17-21		150	Lonely individuals have difficulties to disclose personal information in new relationships and non-structured social situations.
Loneliness and expressive communication	Gerson & Perlman, (1979)	UCLA Loneliness Scale, 1978, The students completed two versions of this scale: one indicating how they had felt during the past two weeks or so, and a	Observation and questionnaires	female undergraduates	The members of the nonlonely group (*n* = 24) had scores in the lower third of the distributions for both recent *(M* =28) and general *(M* = 29) loneliness. The members of the situationally	66	Situationally lonely participants are more successful as communicators than chronically lonely or non-lonely participants.

		second indicating how they usually felt in their life.			lonely group *(n* = 19) had scores in the top third of the distribution for recent loneliness *(M* = *52)*, but in the lower third for general loneliness (M = 34). The members of the chronically lonely group *(n* = 23) had scores in the top third for both recent *(M* = 55) and general *(M* = 60) loneliness.		
Conversational involvement and loneliness	Bell, (1985)	Revised UCLA Loneliness scale (Russell et al., 1980)	Dyadic interaction, recall of conversations and post interaction questionnaires	Undergraduate students	A lonely group was composed of 60 persons (30 males and 30 females) with loneliness scores in the top quarter of the distribution of scores. A nonlonely group was comprised of 60 persons (30 males and 30	60 chronically lonely (M=51.48) and 60 non-lonely (M=24.77) people	Lonely participants have lower rates of talkativeness, interruptions, vocal back-channels, and attention to partners than nonlonely participants. They are also perceived as less involved and less interpersonally attractive by their interaction partner.

					females) with scores in the bottom quarter of the distribution of scores.		
Some communicator correlates of loneliness	Bell & Daly (1985)	Revised UCLA Loneliness Scale (Russell, et al., 1980)	Questionnaires	undergraduates	Loneliness M=34.56, SD=8.70	669	Lonely individuals are apprehensive and anxious about communication and social situations, report difficulty being responsive to others, have problems with self-assertion and self-disclosure, have a constrained and unfriendly style of communication, and evaluate their abilities as communicators negatively.
The conversational style of lonely males with strangers and roommates	Sloan & Solano (1984)	Revised UCLA Loneliness Scale, (1980)	conversation with stranger and roommates, coding of conversation, questionnaires	undergraduates	Loneliness M= 39, SD=10.0; 10 high lonely male (M=55) scored above 1 SD above the mean and 10 non-lonely male (M=32.8) were selected	20	Lonely males spoke less with both same sex strangers, and roommates than non-lonely males. The conversation style of lonely males are less intimate than non-lonely males.

Relationship between loneliness and interpersonal relationships	Moore (1974)	6-point continuum of loneliness questionnaire adapted from Sisenwein, 1964	Questionnaires	college students M=17.5, range 16 to 22	Scores for the Loneliness Questionnaire were rank-ordered. Low and high lonely groups were formed with the 30 lowest (1 to 33) and the 30 highest (95 to 215) scores.	88 females	Lonely participants are significantly more hostile-submissive compare with non-lonely participants.
Adult attachment, social self-efficacy, self-disclosure, loneliness, and subsequent depression for freshman college students: A longitudinal study	Wei, Russell & Zakalik (2005)	Short form of the UCLA Loneliness Scale: 10 items (5 positive and 5 negative items)	Questionnaires	Undergraduates, M=18.31, SD=0.4-7, range=18-20 years	UCLA Positive T1: M12.34, SD=2.92; UCLA Negative T1: M=9.24, SD=2.94	308	Social self-efficacy mediated the relationship between attachment anxiety and loneliness, as well as subsequent depression. Self-disclosure mediated the association between attachment avoidance, loneliness and subsequent depression.
Emotion understanding, interpersonal competencies and loneliness among students	Moroń, (2014)	Study 1: The UCLA Loneliness Scale (Russell, Peplau & Cutrona, 1980), The	Questionnaires	University students, *M*= 21.62 (*SD* = 2.55)	Study 1: Loneliness M=3.15, SD=9.42 Study 2: Romantic loneliness	Study 1: N=221 Study 2: N=206	Loneliness is correlated with a lack of self-disclosure in social relationships. The quality of one's social network is

		Interpersonal Competence Questionnaire, ICQ (Buhrmester, Furnam, Wittenberg & Reis, 1988) Study 2: Social and Emotional Loneliness Scale for Adults – Short version, SELSA-S (DiTommaso, Brannen Best, 2004; Adamczyk & DiTommaso, 2013). The Lubben Social Network Scale, LSNS (Lubben & Gironda, 2003; Lubben et al., 2006) measuring two domains of social network — close			M=3.51, SD=1.89; Family loneliness M=2.74, SD=1.41; Social Loneliness M=2.41, SD=1.24		negatively correlated with family loneliness and social loneliness but not with romantic loneliness.

		relatives and friends					
Social skills of older people: Conversations in same- and mixed-age dyads	Vandeputte et al., (1999)	UCLA Loneliness Scale (Russell, Peplau, & Cutrona, 1980)	Questionnaires, dyadic conversation interactions	Old group, M=73.1, range 66-91; Young group, M=22.4, range 18-25	Young Loneliness M=42.4, SD=9.3; Old Loneliness M=39.5, SD=7.6	76	Loneliness was not related to young or older adults' social skill as measured by partner attention. However, social anxiety was related to social skill during intergenerational conversations.
On the outside looking in: Loneliness and social monitoring	Gardner et al., (2005)	R-UCLA loneliness scale (Russell et al., 1980); number of friends (study 2)	Social memory task (diary study)	undergraduate student	Loneliness is a continuous variable	Study 1: 95 Study 2: 74	A higher level of loneliness is associated with an increased social memory of both positive and negative social events.
Loneliness and the social monitoring system: emotion recognition and eye gaze in a real-life conversation	Lodder et al., (2015)	UCLA Loneliness Scale version 3, 1996	emotion recognition task; eye gaze in conversation study	college students (study 1: 17-24; study 2: 17-27)	Loneliness M=31.98, SD=8.41	170 & 130	Lonely individuals did not show signs of increased social monitoring. However, loneliness is related to increased social monitoring in a real-life social interaction with a peer.
The relation between trust beliefs and loneliness	Rotenberg, et al., (2010)	**Study 1 & 2:** The four-item measure of pure	Questionnaires; memory task,	**Study 1, 2 & 3:**	**Study 1:** Loneliness T1:	Study 1: 278;	Low trust beliefs is linked to elevated level of loneliness

during early childhood, middle childhood, and adulthood		loneliness was developed and used by Ladd, Kochenderfer, and Coleman (1996) with children during early childhood **Study 3:** UCLA Loneliness Scale, 1996, measuring social loneliness and emotional loneliness **Study 4:** UWIST Mood Adjective Checklist (Matthews, Jones, & Chamberlain, 1990) with the addition of shy and loneliness	conversation with the tester	early childhood (5–7 years), middle childhood (9–11 years), and young adulthood (18–21 years) **Study 4:** age *M* = 20 years 8 months	M=10.56, SD=4.49; Loneliness T2: M=9.45, SD=4.33 **Study 2:** Loneliness T1: M=2.15, SD=0.64; T2: M=1.91, SD=1.05; **Study 3:** T1-social loneliness M=5.35, SD=1.76; Emotional Loneliness M=6.57, SD=2.12; T2-Social Loneliness M=5.00, SD=1.52; Emotional Loneliness M=6.15, SD=1.99 **Study 4:** Trust condition, Loneliness M=1.77, SD=0.12;	Study 2: 505; Study 3: 331; Study 4: 80	from childhood to adulthood. Low trust beliefs is linked to social disengagement and cognitive schema mechanism that is associated with this relationship.

					Distrust condition, Loneliness M=2.28, SD=0.12		
Loneliness and peer relations in adolescence	Woodhouse, Dykas & Cassidy (2011)	Questionnaires and peer nomination of other's behaviour and victimisation	New 5-item questionnaire, the adolescent loneliness scale (ALS; Cassidy, 1998).	11th grade students, typically 16–17 years	Loneliness M=8.87, SD=2.97	2,091	Loneliness is positively correlated with victimization and negatively correlated with prosocial and disruptive behaviour. A lack of prosocial behaviour and displaying more shy behaviour predicted adolescents' loneliness score.
Loneliness and Social Skills deficits							
Loneliness within a nomological net: An evolutionary perspective	Cacioppo et al., (2006)	Questionnaires	R-UCLA Loneliness Scale, (1980)	**Study 1:** Undergraduate students **Study 2:** M=57.5, SD=4.5 **Study 3:** 135 Undergraduate Student M=19.23, SD=1.1, range=18-24	**Study 3:** R-UCLA Loneliness Scale at Time 1 were in the upper quintile (high lonely group: total score>44; *M*=51.4), middle quintile (average lonely group: 33<total score<39;	**Study 1:** 2525; **Study 2:** 229 **Study 3:** 135 **Study 4:** 34	Loneliness and depressive affects are separate constructs. Lonely young adults reported a higher level of anxiety, anger, negative mood, and fear of negative evaluation, and reported a lower in optimism, social skills, social support, positive mood,

				Study 4: 34 undergraduate students	*M*=35.3), or lower quintile (low lonely group: total score<28; *M*=24.5); current measure: M high lonely=44.01, SD=9.28; M average Lonely=35.66, SD=7.20; M low Lonely=26.76, SD=4.55. **Study4:** Low lonely: M=29.55, SD=6.09; High lonely: M=58.39, SD=11.84		extraversion, emotional stability, conscientiousness, agreeableness, shyness, and sociability compared with low lonely individuals.
Adolescent loneliness and social skills: Agreement and discrepancies between self-, meta-, and peer-evaluations	Lodder, et al., (2016)	Louvain Loneliness and Aloneness Scale for Children and Adolescents (LACA; Marcoen et al., 1987)	Self-, peer and meta-evaluations of self-report questionnaires	M=13.95, SD=0.54	Loneliness M=18.08, SD=6.18	1342	Loneliness is associated with actual social skills deficits when self-, peer- and meta- evaluation were similar. Some lonely adolescents tend to have social skills deficits whereas others have a perceived social skills deficits.

Poor social skills are a vulnerability factor in the development of psychosocial problems	Segrin & Flora, (2000)	UCLA Loneliness Scale, Version 3; 1996	Questionnaires, longitudinal study	M=17.96, SD=0.42 Range=17-19	Loneliness is a continuous variable in the longitudinal analyses	118	The interaction of social skills and stressful life events, predicted the changes in depression and loneliness. On the other hand, people with effective social skills are assumed to be protected from the development of such problems when stressed.
Loneliness and communication problems: Subjective anxiety or objective skills?	Solano & Koester, (1989)	Revised UCLA Loneliness Scale (Russell, et al., 1980); Differential Loneliness Scale (Schmidt & Sermat, 1983)	Questionnaires	Undergraduates	ANOVA but loneliness as dependent variable	325	Loneliness is strongly associated with anxiety over social skills, for both male and female undergraduates and for a variety of social relationships.
Loneliness, negative life events, and the provisions of social relationships	Bell & Gonzalez, (1988)	Five items, to which students responded with five-point agree-disagree scales: (A) "I am a very lonely person at the present time," (B) "My life has been a	Questionnaires	M=21, SD=3.47	Loneliness M=9.05, SD=4.85	303	Loneliness was most strongly linked to deficits in Guidance, Attachment, and Reassurance of Worth for females, and Social Integration, Guidance, and Opportunities for Nurturance for males.

		very lonely one," (C) "I probably always will be a lonely person," (D) "I am lonelier than other people my own age," and (E) "Other people think of me as a lonely person."					
Social skills, stressful life events, and the development of psychological problems	Segrin & Flora, (2000)	UCLA Loneliness Scale (version 3; 1996)	Questionnaires, longitudinal study	T1. M= 17.96, *SD* = 0.42, range = 17–19	Loneliness M=2.35, SD=0.47	118	Results indicated that poor social skills are causally linked, in small magnitude, to loneliness and anxiety, but less so to depression.
Optimistic, approach-oriented, and avoidance strategies in social situations: Three studies on loneliness and peer relationships	Nurmi et al., (1996)	Revised UCLA Loneliness Scale (Russell, et al., 1980)	Questionnaires and rating by students, tutors	young adults (16-33)	continuous variable in regression	Study 1: 303, Study 2: 71, Study 3: 35	Specifically, the less a person applied an approach-oriented strategy, and the more they used a social avoidance strategy, the lonelier they were.
Social strategies and loneliness: A prospective study	Nurmi & Salmela-Aro, (1997)	UCLA Loneliness Scale (Russell et al., 1980)	Questionnaires	Undergraduates, M=21.63, SD=3.02,	Structural equation models (SEM)	282	The more young adults report using an avoidance social strategy, the more

				(range= 18-32)			lonely they become across time. Individuals who were lonelier early on in the study were less likely to use an approach oriented social strategy later on.
Approach and Avoidance Social Motives and Goals	Gable, (2006)	UCLA Loneliness scale 20 items and 10 items (Russell, Peplau, & Cutrona, 1980)	Questionnaires	Study 1: Undergraduates Study 2: M=19.1, SD=1.7; Study 3: M= 18.81, SD=1.1		Study 1:155 Study 2:114 Study 3: 73	The approach motives were associated with less loneliness and more satisfaction with social bonds, the avoidance motives were associated with a higher level of loneliness, more negative social attitudes, and relationship insecurity.
Perception of lonely and non-lonely persons as function individual differences in loneliness	Rotenberg & Kmill, (1992)	Revised UCLA loneliness scale	questionnaires and descriptions of lonely and non-lonely hypothetical peers	university students	Loneliness M=35.6. High lonely: M=41.73; Non-lonely: M=30.33	96 males and 179 females	Compared with non-lonely individuals, lonely individuals were less accepting of non-lonely people.
Loneliness and social behaviours in	Luhmann, Schönbrodt, Hawkley &	German translation of the revised 20-item	Questionnaires, online	M=29.1, SD=10.23, range= 15-60	Loneliness M=0.92, SD=0.59	176	In a two dimensional browser game, high lonely individuals

a virtual social environment	Cacioppo, (2015)	UCLA Loneliness Scale (1980); The total average score of the scale was calculated.	game interaction				showed more frequent interaction with a spouse before separation from their spouse but showed less frequent interaction after reunion with their spouse.
Choking under social pressure: Social monitoring among the lonely	Knowles, Lucas, Baumeister & Gardner, (2015)	**Study 1:** Loneliness Scale, version 3 (Russell, 1996), 3 items scoring from 1 to 7 (the extent to which they felt left out, isolated from others, and lacking in companionship); 20-item Revised UCLA Loneliness Scale, version 2 (Russell et al., 1980) rating on a 7 point response scale. **Study 2:** UCLA, 1980,	Questionnaires, experimental tasks	Undergraduates	**Study 1:** 3 items UCLA: M=3.33, SD=1.30, ranged from 1.33 to 5.67. R-UCLA (M=2.73, SD=0.95, ranged from 1.10 to 5.55. High lonely individuals were categorised by 1SD above the mean, low lonely individuals were categories by 1SD below the mean. **Study 2:** R-UCLA loneliness scale M=1.77, SD=0.32, Range = 1.20-2.50. High lonely individuals	Study 1: 86 Study 2: 80 Study 3: 93 Study 4: 231	**Study 1:** A higher level of loneliness predicted a worse accuracy at recognising nonverbal emotional faces when the task is socially framed, but loneliness did not predict the results when the task was not socially framed. **Study 2:** Non-lonely individuals performed better at vocal tone

		rating from 1 to 4. **Study 3:** UCLA, 1980, rating from 1 to 6. **Study 4:** UCLA, 1980, rating from 1 to 7.			were categories by 2 standard deviation above the loneliness mean. Low lonely individuals were categories by two third of a standard deviation below the loneliness mean. **Study 3:** R-UCLA loneliness M=1.59, SD=0.79, range=0.40 to 3.90. The least lonely individuals are categorised by 1SD and above the loneliness mean; Lonely individuals are categorised by 1SD and below. **Study 4:** 120 students from the top third of the distribution and 111 from the		recognition when the task was socially framed, whereas high lonely individuals performed worse at vocal tone recognition when the task was socially framed. **Study 3:** A higher level of loneliness lead to worse labelling of emotion of the eye area when the task was socially framed compare with non-lonely individuals. However, in the anagram task, high lonely individuals did not differ from low lonely individuals regardless of the framing of the task.

					bottom third were selected		High lonely individuals perform worst in the emotional recognition task in the non-misattribution condition (they were told to drink a sugar-free fruit drink, which actually contains no caffeine, no sugar and no calories) before completing the emotional recognition task). Taken together, the findings suggest that lonely participants performed worse than non-lonely individuals in social sensitivity tasks framed for social aptitude, but they performed no differently from non-lonely individuals when the same tasks were framed for academic aptitude.

Social intelligence as a predictor of loneliness in the workplace	Silman & Dogan, (2013)	Loneliness in the Workplace Scale (LAWS), the scale has two sub-dimensions: emotional deprivation and social companionship.	Questionnaires	M=39.09, SD=9.38 (range 23-66)	Emotional Deprivation M=20.30, SD=7.53; Social Companionship, M=13.71, SD=5.05	326	Social information processing and social skills, predicted 26% of social deprivation. Social skills and social awareness predicted 13% of social companionship.
Social skills, social support, and psychological distress: A test of the social skills deficit vulnerability model	Segrin, McNelis, & Swiatkowski, (2016)	UCLA Loneliness Scale (Hays & DiMatteo, 1987), is an 8-item shortened version of the original UCLA Loneliness Scale (Russell, 1996, 1978)	Questionnaire, Longitudinal study	M=21.06 (SD = 1.60)	Loneliness is a continuous variable	211	Poor social skills are a risk factor for development of loneliness, because poorer social skills have an indirect effect in predicting lower levels of loneliness through high social support. That is, individuals with poorer social skills tend to develop loneliness because they are less likely to access to social supports.
Social skills deficits among the socially anxious: Rejection	Segrin & Kinney, (1995)	UCLA (Russel, et al, 1978)	Natrualistic interaction, coding of conversation	M=20.8		64	Social anxiety is strongly associated with loneliness. Socially anxious

from others and loneliness			for measuring social skills; Questionnaires				individuals were not rejected by their partners but they reported feeling more lonely compared with non-socially anxious individuals.
Attachment styles, social skills and loneliness in young adults	DiTommaso, Brannen-McNulty, Ross & Burgess, (2003)	The Social and Emotional Loneliness Scale for Adults-Short Form (SELSA-S). measuring three types of loneliness: family, romantic and social.	Questionnaires	university students, M=19.4, SD=1.12, range= 18-22	Loneliness is a continuous variable	183	Attachment security and social skills are significantly related to loneliness. Securely attached individuals are more socially skilled and tend to be less lonely. The link between secure and fearful attachment, and social loneliness was partly mediated by social skills.
The relationship between loneliness, interpersonal competence, and immunologic status in hiv-infected men	Straits-tröster et al., (1994)	UCLA Loneliness Scale (ULS-8; Hays and DiMatteo, 1987)	Questionnaires, blood sample	M=34.4, SD= 6.9, (HIV +); M=38.1, SD=6.8, (HIV-)	Loneliness Baseline, M=16.4, SD=4.9 (HIV +) ; M=14.9, SD=4.2 (HIV -); Loneliness Follow up M=15.8, SD=5.3 (HIV +); M=15.8, SD=4.7 (HIV -)	108	Results suggest that loneliness is related to a broad range of social skills deficits. Less competence in social initiation and less comfort in the domain of self-disclosure were also the best predictors of loneliness at a six

					high-lonely (loneliness ≥ 22) and low-lonely (loneliness < 22)		month follow-up. These results suggest that improved social skills may reduce loneliness and improve quality of life.
Reflective monitoring in lonely adolescents	Carr & Schellenbach, (1993)		Review article				Deficient social skills may be a primary contributor to chronic loneliness during adolescence. Specifically, adolescents at risk of becoming chronically lonely may have trouble reflecting on the appropriateness of their behaviour, and learning from their actions.
Social skills training for withdrawn unpopular children with physical disabilities: A preliminary evaluation	King et al., (1997)	24-item Loneliness Scale (Asher et al., 1984)	Social skills training program, questionnaires	M=12, age between 8-15	Children with disability, Loneliness M=39.82, SD=13.30. Children without disability, M=32.50, SD=11.80	21	Applied social skills intervention programs including 5 aspects: interpersonal problem solving, verbal and nonverbal communication, initiating interactions with peers, conversational skills,

							and coping with difficult others, reduced feeling of loneliness in physically disabled children.
Psychosocial predictors and outcomes of loneliness trajectories from childhood to early adolescence	Schinka, van Dulmen, Mata, Bossarte & Swahn (2013)	Loneliness and Social Dissatisfaction Questionnaire (Asher, Hymel, & Renshaw, 1984)	Questionnaires, 4 points of data collection from birth to age 15.	Age between 9 to 15	5 trajectories of loneliness: stable low (49.1%, N= 408), moderate increasing (31.6%,N = 263), high increasing (4.5%, N = 37), decreasing (10.7%, N = 90), and chronic (4.1%, N = 34).	1,364	Children's changing in loneliness level falls into 5 different trajectories across adolescence. Poor social skills along with other psychosocial factors predicted loneliness at a later time. Chronic and increasing loneliness predicted a series of psychosocial outcomes, including poorer social skills at a later time.
Self-perceptions of social interactions and social relationships (negative self-evaluation)							
Loneliness in everyday life: Cardiovascular activity, psychosocial context, and health behaviours	Hawkley, Burleson, Berntson & Cacioppo (2003)	R-UCLA Loneliness Scale, (Russell et al., 1980)	Cardiovascular Equipment, Diary Measures, individual differences	M=19.2; undergraduate students	Loneliness group is defined by lower quintile (total score ≤ 28; N= 22 men, 22 women), middle (total score ≥ 33	135	Loneliness predicted lower interaction positivity and higher interaction negativity.

			questionnaires		and < 39; N= 23 men, 23 women), and upper quintile (total score ≥ 46; N= 23 men, 22 women) of scores on the R-UCLA Loneliness Scale. Recruitment Loneliness, M=37.0,SD=11.0; Laboratory testing Loneliness M=35.4, SD=10.1		
Cognitive and situational precipitants of loneliness among patients with cancer: A qualitative analysis	Adams et al., (2016)	Participants were asked to describe any experiences of loneliness since their cancer diagnosis.	Qualitative interview	Cancer patients Mean age=62.6, SD=11.9, range: 43-77	Several participants said they felt lonely during periods of physical isolation.	15	Cancer patients reported feeling lonely when they had negative thoughts about their social situations.
Experiencing loneliness in adolescence: A matter of individual characteristics, negative peer experiences, or both	Vanhalst, Luyckx & Goossens, (2013)	loneliness and aloneness scale for children and adolescents (Marcoen, Goossens, & Caes, 1987)	Self- and peer-report questionnaires	M=15.79, SD=1.33		884	The association between shyness, self-esteem and loneliness is partially mediated by friendship quality and quantity.

Adolescent loneliness and social skills: Agreement and discrepancies between self-, meta-, and peer-evaluations	Lodder, et al., (2016)	Louvain Loneliness and Aloneness Scale for Children and Adolescents (LACA; Marcoen et al., 1987)	Self-, peer and meta-evaluations of self-report questionnaires	*M*=13.95, *SD*=0.54	Loneliness *M*=18.08, *SD*=6.18	1342	Some lonely adolescents experienced social skills deficits, whereas others experiences a bias in rating one's social skills: that when they rate their social skills more positively or more negatively compare with their peers, adolescents reported a higher level of loneliness.
The persistence of loneliness: Self and other determinants	Jones, Freemon, & Goswick, (1981)	UCLA Loneliness Scale (Russell, Peplau, & Ferguson, 1978)	Self-reported questionnaires after dyadic interactions	Undergraduate students	Study 2: Median split, Loneliness Median Women=37.5; Median Men=38.0; A total of 35 dyads were tested: 9 lonely female/lonely male; 9 lonely female/nonlonely male; 10 nonlonely female/lonely male; and 7 nonlonely	Study 1: 210 Study 2: 70	Lonely students (a) rated themselves more negatively and reported deficits in social skills; (b) rated others more negatively and hold a negative view towards people in general; (c) expected others to rate them negatively, but (d) in general were not rated by others differently.

					female/nonlonely male.		
Loneliness and interpersonal judgements	Jones, Sansone & Helm, (1983)	UCLA (Russel, et al, 1978)	Dyadic interaction and questionnaires		Degrees of loneliness is defined by the upper and lower one third of distribution of loneliness scores; The number of dyads include 12 high lonely – high lonely dyads, 12 low lonely-high lonely dyads, 7 high lonely-low lonely dyads and 11 low lonely – low lonely dyads.	screened 250 and selected 42 dyads	High lonely individuals give more negative self-ratings, expect their partners to rate them more negatively compare with low lonely individuals. High lonely participants were perceived by their partners as more likely to rate themselves negatively. The ratings of partners and the partners' ratings of a lonely person differs by gender, with high lonely males rate their partners, and been rated by their partners more negatively, whereas high lonely females did not receive the same negative ratings.
Loneliness and the evaluation of relational events	Duck, Pond & Leatham, (1994)	Revised UCLA loneliness scale	social interaction and	University students, M=20.5	High and low loneliness is defined by	32 pairs, 64 individuals	Lonely people did not always rate their social interactions

			questionnaire, and self-evaluate their own videotape of social interaction 6 weeks after		median split, T1: High Lonely Group Median=38.72, N=32; Low Lonely Group Median=29.87, N=32; T2. High Lonely group Median=38.94, N=34; Low Lonely group Median=29.56, N=30		negatively, but they perceived the quality of these interactions lower. However, they draw negative conclusions about their own relationships after viewing a videotape of their own social interaction 6 weeks after.
Some communicator correlates of loneliness	Bell & Daly (1985)	Revised UCLA Loneliness Scale (Russell, et al., 1980)	Questionnaires	undergraduates	Loneliness M=34.56, SD=8.70	669	Lonely individuals evaluate their abilities as communicators as less competent.
Perceptions by and of lonely people in social networks	Tsai & Reis, (2009)	Revised UCLA Loneliness Scale (Russell, et al., 1980)	questionnaires	undergraduates (18-23)	Loneliness M=2.13, SD=0.56	73	Lonely people were more negative toward closer social acquaintances and somewhat positive toward less close acquaintances. Lonely people had lower self-ratings and perceived self-perceptions, and

							were rated more negatively by others.
Perceptions of and by lonely people in initial social interaction	Christensen & Kashy, (1998)	Revised UCLA Loneliness Scale (Russell, et al., 1980)	Questionnaires, group decision making tasks and post interaction questionnaires.	undergraduates	Mean loneliness=39.73, SD=7.79	220	Lonelier people viewed themselves negatively, and believe others would rate them negatively, lonely individuals viewed others more positively and were seen by others as friendlier.
The social reality of feeling lonely, friendship and reciprocation	Wiliams & Solano, (1983)	Revised UCLA Loneliness Scale (Russell, et al., 1980)	questionnaires	undergraduates	Loneliness Score Female M=39.9; Loneliness Male M=33.8 For the friendship reciprocal nomination, Lonely group M=52.5, N=8; Average group M=38.5, N=6; Non=lonely group M=28.0, N=8	22 females and 20 males	Lonely individuals, perceive a significantly lower level of intimacy in their friendships and their friends also reciprocally reported low intimacy. Lonely people listed as many friends as non-lonely people, but their friends were less likely to return this friendship nomination.
Poor social performance of lonely people: Lacking a skill or adopting a role?	Vitkus & Horowitz, (1987)	Revised UCLA Loneliness Scale (Russell, et al., 1980)	Questionnaire and social interaction	undergraduates	Subjects who scored at least .90 standard deviations above the mean were	24 lonely and 24 non-lonely individuals	Lonely participants did not differ from nonlonely participants in social behaviour. Lonely individuals

					considered "lonely," and those who scored at least .90 standard deviations below the mean were considered "nonlonely."	of 621 screened	rated themselves negatively and reported feeling more depressed, more hostile and marginally more anxious after the social interaction.
Multilevel modelling of social interactions and mood in lonely and socially connected individuals, the MacArthur social neuroscience studies	Hawkley, Preacher & Cacioppo, (2007)	Revised UCLA Loneliness Scale (Russell, et al., 1980)	Experience sampling methodology (ESM), Participants complete a diary for 7 days	Undergraduates, M=19.2, SD=1.0.	The 3 lonely groups are defined by the upper quintile of the RUCLA scores. Lower quintile (total score ≤ 28), middle quintile (total score ≥33 and < 39), and upper quintile (total score ≥ 46)	135	Loneliness is characterised by initial negativity and the tendency to self-reinforce the negativity in social interactions.

Loneliness and relationally competent communication	Spitzberg & Canary, (1985)	Loneliness Chronicity Scale, Young 1979b; Abbreviated Loneliness Scale (Ellison & Paloutzian, 1979)	Conversation exercise	undergraduate students	Three groups. Based on 1 standard deviation of the mean score of loneliness. High Lonely >31; 20< Medium lonely <31; Low lonely <20	188	Chronically lonely people perceive their own and other's communicative competence negatively. They are also perceived by their conversation partners as less competent at social relationships.
Behavioral and characterological attributional styles as predictors of depression and loneliness: Review, refinement, and test	Anderson et al., (1994)	Revised UCLA Loneliness Scale (Russell, Peplau, & Cutrona, 1980)	Questionnaires	undergraduates	Sample 1: Loneliness M=36.69; Sample 2: M=39.07	Sample 1: 625; Sample 2: 282	Both behavioural and characterological self-blame attribution (attribute failure and success to selves' behaviour and characters) contribute uniquely to depression and loneliness.
Dimensions of perfectionism, psychosocial adjustment, and social skills	Flett, Hewitt & Rosa, (1996)	UCLA Loneliness Scale (Russell, Peplau, & Cutrona, 1980)	Questionnaires	University students	Correlational study	105	Socially prescribed perfectionism was associated strongly with loneliness.
Naturalistic observations of schoolyard social participation: Marker variables for socio-emotional	Coplan, Ooi & Rose-Krasnor, (2015)	Loneliness and Social Dissatisfaction Questionnaire (Asher & Wheeler, 1985)	Questionnaires and observation	Mage = 10.20 years, SD = 0.96	Cluster Analysis, Loneliness M=1.93, SD=0.64, range=1-5	290	Non-social children reported the highest levels of social anxiety, depression, and loneliness. They were also rated by

functioning in early adolescence							their mothers as having more interpersonal and emotional problems compared with socially active children.
Loneliness, attachment, and the perception and use of social support in university students	Bernardon, Babb, Hakim-Larson & Gragg (2011)	The Social and Emotional Loneliness Scale for Adults - Short Form, SELSA-S; DiTommaso, Brannen, & Best, (2004)	Questionnaires	*Mage* = 22.15, *SD* = 5.55, age range: 18 to 54 years.	Romantic loneliness (*M* =3.17, *SD* =1.94), family loneliness (*M* = 2.40, *SD* =1.40), social loneliness (*M* = 2.46, *SD* =1.09).	179	Model of self was associated with less family loneliness, less social loneliness and less romantic loneliness. Model of others is associated with less family loneliness, less social loneliness and less romantic loneliness.
Oher's perceptions							
The persistence of loneliness: Self and other determinants	Jones, Freemon, & Goswick, (1981)	UCLA Loneliness Scale (Russell, Peplau, & Ferguson, 1978)	Self-reported questionnaires after dyadic interactions	Undergraduate students	Study 2: Median split, Loneliness Median Women=37.5; Median Men=38.0; A total of 35 dyads were tested: 9 lonely female/lonely male; 9 lonely	Study 1: 210 Study 2: 70	Lonely students (a) rated themselves more negatively and reported deficits in social skills; (b) rated others more negatively and hold a negative view towards people in general; (c) expected others to rate them negatively, but

					female/nonlonely male; 10 nonlonely female/lonely male; and 7 nonlonely female/nonlonely male.		(d) in general were not rated by others differently.
I'm lonely, can't you tell? Convergent validity of self- and informant ratings of loneliness	Luhmann, Bohn, Holtmann, Koch & Eid, (2016)	9-item short version of the UCLA Loneliness Scale (German version by Döring & Bortz, 1993; Russell, 1996).	Self-reported questionnaire and informant ratings from their parents, friends, and romantic partners.	Mage =18.22, SD= 0.58.	MTMM correlation model	463	Romantic partners, friends and parents' ratings of loneliness can be used as valid indicators of one's actual loneliness level.
Conversational involvement and loneliness	Bell, R. A. (1985)	Revised UCLA Loneliness scale (Russell et al., 1980)	Dyadic interaction, recall of conversations and post interaction questionnaires	Undergraduate students	A lonely group was composed of 60 persons (30 males and 30 females) with loneliness scores in the top quarter of the distribution of scores. A nonlonely group was comprised of	60 chronically lonely (M=51.48) and 60 non-lonely (M=24.77) people	Lonely participants had lower rates of talkativeness, interruptions, vocal back-channels, and attention than non-lonely participants. They were also perceived as less involved and less

					60 persons (30 males and 30 females) with scores in the bottom quarter of the distribution of scores.		interpersonally attractive.
Perceptions by and of lonely people in social networks	Tsai & Reis, (2009)	Revised UCLA Loneliness Scale (Russell, et al., 1980)	questionnaires	undergraduates (18-23)	Loneliness M=2.13, SD=0.56	73	Lonely people were more negative toward closer social acquaintances and somewhat positive toward less close acquaintances. Lonely people had lower self-ratings and perceived self-perceptions, and were rated more negatively by others.
Perceptions of and by lonely people in initial social interaction	Christensen & Kashy, (1998)	Revised UCLA Loneliness Scale (Russell, et al., 1980)	Questionnaires, group decision making tasks and post interaction questionnaires.	undergraduates	Mean loneliness=39.73, SD=7.79	220	Lonelier people viewed themselves negatively, and believe others would rate them negatively, lonely individuals viewed others more positively and were seen by others as friendlier.

The social reality of feeling lonely, friendship and reciprocation	Wiliams & Solano, (1983)	Revised UCLA Loneliness Scale (Russell, et al., 1980)	questionnaires	undergraduates	Loneliness Score Female M=39.9; Loneliness Male M=33.8 For the friendship reciprocal nomination, Lonely group M=52.5, N=8; Average group M=38.5, N=6; Non=lonely group M=28.0, N=8	22 females and 20 males	Lonely individuals, perceive a significantly lower level of intimacy in their friendships and their friends also reciprocally reported low intimacy. Lonely people listed as many friends as non-lonely people, but their friends were less likely to return this friendship nomination.
The social stigma of loneliness: Effect of target person's and perceiver's sex	Lau & Gruen, (1992)	N/A	Rating of a script describing lonely and non-lonely figures	University students		96	The created lonely person was perceived as lower in psychological adjustment, and less socially competent. The lonely person was rated more negatively in general, and was seen as lack of interpersonal effectiveness.
Stigmatization of transitions in loneliness	Rotenberg (1998)	N/A	questionnaires and descriptive of lonely and non-lonely	University students. M=20 years 5 months (18-30)		204	Students' rating of the psychosocial functioning of a hypothetical peer

			hypothetical peers				distributed from lowest to highest: no-transition lonely, transition lonely, transition non-lonely and no-transition non-lonely.
Differences in loneliness and social behaviour of immigrant and repatriated preschoolers	Chatzigeorgiadou, Pavlidou & Arvanitidou, (2011)	Loneliness and social dissatisfaction (Cassidy & Asher, 1992)	Questionnaires and teachers ratings of behaviour	Kinder garden children	20.8% of immigrant and repatriated pre-schoolers reported greater loneliness and social dissatisfaction compare with their native peers (12.29%)	93	High-lonely kinder garden children were considered by teachers as more disruptive compared with non-lonely children.
Low Self-Esteem as a Risk Factor for Loneliness in Adolescence: Perceived - but not Actual - Social Acceptance as an Underlying Mechanism	Vanhalst, Luyckx, Scholte, Engel & Goossens (2013)	Loneliness and Aloneness Scale for Children and Adolescents (LACA; Marcoen et al. 1987)	Questionnaires, longitudinal study	Dutch adolescents M= 15.22 at T1; Belgian adolescents M =14.95 at T1	**Study 1:** T1 Loneliness Boys M=1.50 (0.52); Girls M=1.60 (0.52); T2 Boys= 1.45 (0.51); Girls=1.57 (0.51); T3Boys=1.47(0.50),Girls=1.60(0.58); T4 Boys=1.40(0.46); Girls=1.53(0.52); T5Boys=1.37(0.4	N=428, N=882	Loneliness is associated with both perceived social acceptance and actual social acceptance. A higher level of perceived social acceptance predicted later decreases in loneliness, but actual social acceptance was not related to the changes of

					2),Girls=1.50(0.48) **Study 2:** T1 Boys=1.60 (0.47), Girls=1.65(0.57); T2Boys=1.55(0.45);Girls=1.55(0.47); T3 Boys=1.57(0.47); Girls=1.62(0.52)		adolescents' loneliness level over time.
Loneliness and friendships							
Adolescents' loneliness and depression associated with friendship experiences and well-being: A person-centered approach	Spithoven et al., (2016)	Loneliness and Aloneness Scale for Children and Adolescents (LACA; Marcoen et al. 1987)	Questionnaires	M=12.47 sample 1; M=12.81, sample 2	Loneliness *M* = 1.73, *SD* = 0.62; 4 groups for the cluster analyses. Common group: Adolescents scoring below 1SD on both loneliness and depressive symptoms (N=858); Depressed group: scoring below 1SD on loneliness but above 1SD on depressive symptoms (N=83); Lonely	2 samples: 417 and 1,140	Loneliness and depressive symptoms were related to friendship quantity and quality differently. Individuals in the high lonely cluster reported a lower level of friendship quality and friendship quantity compare with those in the high depressive symptoms cluster.

					Group: scoring 1SD above the loneliness score but 1SD below the depressive symptoms (N=93); Co-occurring groups: Scoring 1SD above the mean on both depressive symptoms and loneliness. (N=73)		
Assessing peer network and dyadic loneliness	Hoza, Bukowski & Beery (2000)	Peer Network and Dyadic Loneliness Scale (PNDLS), measuring network loneliness and peer dyadic loneliness	questionnaires	M=12.40	Peer network loneliness M=1.65, SD=0.60; Peer dyadic loneliness M=1.45, SD=0.54	209	Network loneliness was associated with absence of peer group relationship whereas dyadic loneliness was associated with an absence of quality dyadic friendship.
Social and emotional loneliness: A re-examination of Weiss' typology of loneliness	DiTommaso & Spinner (1997)	Social and Emotional Loneliness Scale for Adults (SELSA), (DiTommaso & Spinner, 1993)	Questionnaire measure at 2 time points	university students	Romantic Loneliness M=42.5, SD=20.9; Family Loneliness M=20.2, SD=11.0; Social	241	The results support a multi-dimensional construct of loneliness that romantic, family and social loneliness are distinctively associated with

					Loneliness M=30.6, SD=13.6		different domains of social provisions.
Popularity, friendship quantity, and friendship quality: Interactive influences on children's loneliness and depression	Nangle, Erdley, Newman, Mason & Carpenter (2003)	Asher and Wheeler (1985) Loneliness and Social Dissatisfaction Questionnaire	self-report questionnaires and rating of a partner	children (3rd to 6th grade)	Loneliness Male M=2.02, SD=0.61; Loneliness Female M=2.05, SD=0.60	193	Popularity only affect loneliness and depression indirectly whereas dyadic friendship quality most directly affect loneliness and depression.
Romantic relationships and psychological distress among adolescents: Moderating role of friendship closeness	Chow, Ruhl & Buhrmester (2015)	20-item Revised UCLA Loneliness Scale (Russell, Peplau, & Cutrona, 1980), range from 1 to 4.	questionnaires	12th grades adolescents (M=17.6, SD=0.63) and their parents and a same-sex best friend	Boys Loneliness M=1.59, SD=0.41; Girls Loneliness M=1.63, SD=0.49	110	Romantic security and friendship closeness predicted loneliness independently.
Loneliness in the daily lives of young adults: Testing a socio-cognitive model	Van Roekel, Ha, Scholte, Engles & Verhagen (2016)	UCLA; Russell, Peplau, & Cutrona, 1980, average score across 20 items, range=1.05-3.20	Consecutive diary study	First year psychology students M age=19.60, SD-1.46	Loneliness M=1.80, SD=0.48	219	High lonely students are hypersensitive to social threat as they reported more negative affect when they are with a perceived negative company. High lonely students are hyposensitive to social rewards as they showed more positive affect after interacted

							with a perceived positive company.
Loneliness, affect, and adolescents' appraisals of company: An experience sampling method study	van Roekel, et al., (2013)	Louvain Loneliness Scale for Children and Adolescents (LLCA; Marcoen, Goossens, & Caes, 1987) Range=12-48	Questionnaires, Momentary assessments	M=14.19, SD=0.55, range=13-16	Baseline Loneliness M=17.68, SD=5.39	339	Adolescents with higher levels of baseline loneliness were more negatively affected by negative company, and more positively affected by a positive company.
Selection and socialization of internalizing problems in middle childhood	Mercer & DeRosier (2010)	Loneliness and Social Dissatisfaction Questionnaire (Asher & Wheeler, 1985)	Friend Nominations, data collected at 2 time points	Elementary school children	Loneliness T1 M=4.52, Loneliness T2 M=4.43	1,016	Results suggested that children tended to become friends with those who have a similar level of loneliness as them. Moreover, loneliness is contagious across children, that children's level of loneliness becomes similar with their friends' average loneliness level over time.
What are friends for? Friendships and loneliness over the life span from 18 to 79 years	Nicolaisen & Thorsen (2016)	A global question about loneliness ("Do you feel lonely?") Those	Questionnaires	Different age group from 18 to 29, 30 to 49, 50 to 64, and 65 to	Never Lonely: 41.6%, Seldom Lonely: 37.5%; Sometimes Lonely: 18.2%;	14,725	20.8% of the total sample reported feeling lonely often or sometimes. Loneliness is distributed as "U"

		who experience loneliness often or sometimes are considered lonely.		79. Age range=18-79	Often Lonely: 2.7%		curve regarding age, with the youngest age group and oldest age group reporting of feeling more lonely.
Adolescent loneliness and social anxiety: The role of multiple sources of support	Cavanaugh & Buehler, (2016)	8-item UCLA Loneliness Scale (Russell, Peplau, & Ferguson, 1978). Loneliness also was measured using a single item, ‘‘I feel lonely,’’	Questionnaires	M=11.86, SD=0.69; 11 to 14 years	Structural equation modelling	Wave 1: N= 416; Wave 2: N=366; Wave 3: N=340	Parental support was associated with decreased loneliness level; Peer support was associated with decreased level of social anxiety in early adolescents.
Friendship expectations and children’s friendship-related behavior and adjustment	MacEvoy, Papadakis, Fedigan & Ash, (2016)	Asher and Wheeler’s (1985) Loneliness and Social Dissatisfaction Scale	questionnaires	Mage = 9.88 years, SD=0.91	Loneliness T1 Boys M=5.23, T2 boys M=5.10, T3 Boys M=5.04; Loneliness T1 Girls M=6.14, T2 Girls M=5.29, T3 Girls M=5.01	499	Children’s self-reported higher friendship expectations were found to be associated with a lower level of loneliness.
Aspects of girls’ friendships: Practice implications for internalizing problems	Ralph & Epkins, (2015)	The Peer Network and Dyadic Loneliness Scale measuring peer	Questionnaires, friendship nomination	M age = 9.97, SD = 0.75	Dyadic loneliness M=1.81, SD=0.60; Peer network	116 girls	Girls' perceived similarity to her nominated friend was uniquely related to their perceived

		network loneliness and dyadic loneliness (PNDLS; Hoza et al. 2000)			loneliness M=1.53, SD=0.53		positive friendship quality. A higher level of dyadic loneliness is related to girls' perceived lower level of friendship quality with their nominated friend.

Chapter 3: Cognitive Bias in Lonely People: Cross-sectional and Longitudinal Examination

Introduction

Research inspired by a cognitive account of loneliness (for example, Cacioppo & Hawkley, 2009) suggests that cognitive biases may contribute to the development and maintenance of loneliness. Research in this area has typically focused on the maladaptation of attention, interpretation, and memory processes in lonely individuals. The key purpose of the present study was to determine whether the processing of emotional information in individuals reporting a higher degree of loneliness differed from those who reporting less loneliness. The current study is original in exploring cognitive processes in lonely people systematically by 1) exploring both the attention and memory process towards task-irrelevant emotional information, 2) explore both attention and memory processes in the same study sample longitudinally.

Cognitive biases are conceptualised as a factor that contributes to many emotional disorders (Everaert, Duyck & Koster, 2015), including depression (Gotlib & Joormann, 2010), social anxiety (Clark, 2001), phobias anxiety (Mogg et al., 1990), spider phobias (Watts, McKenna, Sharrock & Trezise, 1986), borderline personality disorders, and Post-Traumatic-Stress- Disorder (Cottencin, et al., 2006). Emotional material related to an individual's fear (e.g., words such as 'spiders') is found to be attended differently to non-emotional material in many clinically vulnerable groups (e.g., individuals with spider phobia), but these effects are not found in control group wherein participants do not report spider phobia. For example, using an emotional Stroop paradigm, individuals with higher anxiety disorder showed a slower naming of all words and were particularly slower at naming threat words than non-threat related words (Mathews & MacLeod, 1985); individuals with borderline personality disorders, which is a disorder characterised by an emotional dysregulation, compulsive cognitive and behavioural functioning, and often co-occurred with anxiety (Bulbena-Cabre et al., 2017), tend to show a difficulty in forgetting the negative information in a directed forgetting task (Domes, et al., 2006). Cognitive biases often occurs because it acts as an information processing shortcuts, or heuristics (Simola, 2015). Because individuals need to

provide fast and accurate decisions in everyday lives, the mental heuristics were introduced to speed up the systematic interpretation and perceptions of the incoming sensory information. Cognitive biases occurs when the mental shortcuts employ systematic errors which conflicts individuals' objectives and rational choices (Simola, 2015). The cognitive biases usually links to the maintenance of emotional disorders because during the episode of an emotional disorder, the cognitive biases often drives the individuals to process information in congruent with an individuals' emotional state (Gotlib & Joormann, 2010). For example, individuals experience major depressive disorders tend to endure their bias processing during the depressive episode, the cognitive biases thus contribute to the onset and recurrence of depression (Gotlib & Joormann, 2010).

The prominent findings in the research domain of loneliness lie in the attention, interpretation, and memory toward social stimuli. In general, the findings so far suggest that people with a higher level of self-reported loneliness scores have an implicit attentional bias towards social threat and an explicit memory bias towards social information (Cacioppo et al., 2015). An increasing amount of research in all demographics in this area suggest that individuals with a higher level of loneliness were likely to direct their attention to social threat scenes quicker than non-lonely counterparts (Bangee et al., 2014; Qualter et al., 2013), quickly disengaged from threat after initial fixation (Bangee et al., 2014), showed poorer attentional control, suggesting that they have difficulties in the top-down control of attention (Cacioppo et al., 2000; Harris, 2014), a heightened incidental memory of social events (Gardner, Pickett, Jefferis, & Knowles, 2005), spending longer gazing their conversation partner' face (Lodder et al., 2015), and are more accurate at recognising emotional faces (Vanhalst et al., 2015).

A systematic review by Spithoven, Bijttebier and Goossens (2017) concluded that loneliness is related to cognitive biases in all stages of information processing, including attentional bias, perception bias, and negative evaluation. The review outlined that memory bias may be a key component in the information processing stage exhibited in lonely individuals. Yet, research in this area did not examine the cognitive biases thoroughly, and the area of memory bias in loneliness generally, is particularly under-researched.

The current thesis used three cognitive paradigms to examine whether lonely individuals display explicit attentional and memory bias towards negative social stimuli. The study aimed to examine whether high lonely individuals display cognitive bias towards social threat stimuli in 1) attentional regulation and serial short-term memory by using a Serial Recall task, 2) attentional control and speed of processing by using an emotional Stroop task, and 3) long term/episodic memory and inhibition of irrelevant information by using a Directed Forgetting task.

It is predicted that, negative information that is related to one's fear (Williams, Mathews, & MacLeod, 1996), or self-qualities (Conway, Cowan & Bunting, 2001) may temper their performances of the task at hand. Words, texts, sounds, and speech containing emotional meanings, especially socially threatening in nature (e.g. humiliate, hate), may disrupt performance on attention and memory tasks requiring strategic processing in lonely individuals compared with their non-lonely counterparts. Considering rumination mediate the relationship between peer-related loneliness and depressive symptoms and moderate the relationship between parent-related loneliness and depressive symptoms (Vanhalst et al., 2009). An individuals with a higher level of self-reported loneliness may be preoccupied with negative thoughts and worry of social interactions, despite their best efforts to avoid attending this information/preventing it from entering short-term memory, the information may still do so, thereby disrupting their execution of a task.

Choices of Cognitive Paradigms

Serial recall. The serial recall task involves the visual presentation of a short list of digits followed by an immediate recall of those items in their order of presentation. A variant of the irrelevant sound effect paradigm (e.g., Colle & Welsh, 1976; Salamé & Baddeley, 1982) was adopted whereby participants attempted to memorise the order of visual items while exposed to auditory distractors of different (positive and negative) valence that they were instructed to deliberately presentation of a short list of digits followed by an immediate recall of those items in their order of presentation. A variant of the irrelevant sound effect paradigm (e.g., Colle ignore. The goal was to measure the potential disruptive impact of emotionally valent sounds on serial recall performance (Buchner et al., 2004) and whether, in turn, any

valence-based disruption is exacerbated or attenuated as a function of the self-reported loneliness of the participant.

Since the meaning of irrelevant sound does not typically disrupt serial recall performance (Marsh, Hughes, & Jones, 2008), an impairment due to the emotional valence of an ignored stream of words (e.g., Buchner et al., 2004) likely reflects a specific case of automatic attentional capture due to the emotional properties of the words. Attentional capture is known to be modulated by task-engagement (Hughes, Hurlstone, Marsh, Vachon, & Jones, 2013). Thus, it can be reasonably expected that performance on the task in the presence of valent distractors is mediated by attentional control. It is suggested that lonely individuals who have a tendency to be vigilant toward social threat information will be more negatively affected by social threat distractors than their non-lonely counterparts (Cacioppo et al., 2015). In other words, lonely participants' capacity to exercise attentional control to complete the focal task will be threatened by their vigilance to the social threat material. Thus, it is expected that the serial recall performance of lonely individuals will be poorer than non-lonely individuals for trials in which they are exposed to social threat distractors. In a serial recall task conducted by Harris (2014), lonely children were found to be distracted by to-be-ignored auditory distractors regardless of their valence. However, children are generally more distractible than adults (Elliott et al., 2016), so the failure to find an effect of valence was because there was little room for a valence effect to be observed (for example, in Harris's study, even neutral distractors were very attention grabbing for children). In the current study, the situation may be different because adults are less distractible than children, the effect on the neutral distractors as children are not expected to be observed. Therefore, there are more room to observe a valence effect if lonely adults are lack of attentional control in the in the condition when they were exposed to background speech.

Emotional Stroop. An "emotional variant" of the Stroop task was adopted (for a review, see Williams et al., 1996). The classic Stroop interference refers to the finding that the latencies to name ink colour of incongruent colour words (e.g. name the ink colour of the word red printed in green ink) is longer than the latencies for naming the colour of the ink of congruent colour words (e.g. name the ink colour of

word red printed in red ink). The Emotional Stroop task is a modified version of this paradigm. It is used to investigate the interference effects of emotional materials on cognitive processing. It is frequently used to measure attentional bias, especially bias to threats that are related to the issues that particularly concern the participant (Williams, et al., 1996), for example, "spider" for individuals who are spiderphobics.

Early theoretical frameworks, such as the Automatic Vigilance Hypothesis proposed by Pratto and John (1991), suggest that the interference effect, which usually represented with a delayed reaction time in colour naming, was produced when emotional stimuli captures attention, which results in a slower colour response to the negative emotion words compared with neutral words (Sutton et al., 2007). Such processes create a conflict between bottom-up processing of the meaning of each word with the top-down processing of naming the colour. Neutral words are less likely to capture attention than negative words, therefore, producing a less interference with the processing of the task-relevant information (Frings & Wühr, 2012).

Emotional Stroop interference has been found in many clinical conditions, for example, Mathews and MacLeod (1985) found that anxious patients were slower in naming the colour of threat-related words. Stroop interference has been found from spider-related words in the case of spider-phobic patients (Watts, et al, 1986). Similar Stroop interference effects have been found with patients with general anxiety (Mogg, Mathews & Weinman, 1989), panic disorder (Ehlers et al., 1988, McNally et al., 1994), and rape victims (Foa et al., 1991).

However, many also argued that there is both "fast" and "slow" emotional Stroop effect (for example, Frings et al., 2009; McKenna, 1986; McKenna & Sharma, 2004; Sutton, et al., 2007; Wyble, Sharma & Bowman, 2005). A fast effect replicates the typical emotional Stroop interference that the neutral words were named faster than the emotional words. A slow effect means that an individual's naming of neutral words is slower than their naming of emotional words in an emotional Stroop task (Cane, Sharma & Albery, 2009; McKenna & Sharma, 2004; for a review, see Phaf & Kan, 2007). The design was different in the studies that report these two opposite effects. For the design in which the fast effect emerged,

neutral words were presented after the emotional words, while the design in which the slow effect emerged had the neutral words presented after emotional words.

McKenna and Sharma (2004) argued that a slow effect can occur in emotional Stroop because of an emotional lingering effect. In a block presentation of emotional Stroop conducted by McKenna (1986), the results show that if the session of emotional words was presented before the session of neutral words, the Stroop interference effect is found in neutral words. The slow effect was found in many other studies, for example, McKenna & Sharma (2004), Waters et al., (2005). Cane et al., 2009), and provided the debate in the area of Stroop interference mechanism interpretation. Whereas the previous research outlined that the emotional Stroop is linked to automatic attentional capture by the emotional sounds, the slow effect in the emotional Stroop task suggest that the effect is linked to the character of the preceding words (Frings & Wühr, 2012).

Previous literature suggests that lonely individuals are hypervigilant towards social threat information (e.g., Qualter et al., 2013). Therefore, it was expected that lonely individuals will have a bias for selectively processing negative social information. Thus, the current study focused on potential Stroop interference differences in lonely and non-lonely people in naming the colours in which social threat stimuli and other categories of stimuli are written. Finding an effect of social threat material on Stroop interference would complement Cacioppo et al's (2015) study using the social Stroop task in which it was found that when completing the emotional Stroop task, the negative social stimuli differed quicker than the non-social stimuli in the lonely as compared with non-lonely brains. Specifically, the brain activation pattern differed in the brain of high lonely individuals after viewed the negative social and non-social stimuli in 280 milliseconds. The negative social words, compared with negative non-social words in the social Stroop task, elicited more activation in the brain regions in the lonely brain include extrastriate cortex, fusiform cortex, frontal eye field, dorsolateral prefrontal cortex, anterior prefrontal cortex extending to the dorsal anterior cingulate which links to the orienting and executive control aspects of visual attention (Cacioppo et al., 2015).

Taking findings from previous research, the current study predicted that lonely individuals would take longer to overcome interference from automatically

processing the semantic meaning of a social threat word, thereby increasing reaction time for naming the colour of that social threat word. The current study also used words that have semantic meaning of physical positive, physical threat, social positive and neutral to examine whether lonely individuals exhibit Stroop interference in processing words with other semantic meaning. Because these categories of words are characterised by having a high arousal levels and have a high or low valence (Scott, O'Donnell, Leuthold & Sereno, 2009). The use of emotion words in studying individual's cognitive process in relation to emotional disorders is also widely used and effective in exploring how the person react to the words that is associated with oneself or one's worry or fear (González-Garrido, Gómez-Velázquez, Sequeira, Ramos-Loyo & López-Franco, 2013). Lonely individuals, which is characterised by specific attentional bias towards rejection information in social contexts (Bangee & Qualter, 2018), and a memory bias favours social information (Gardner et al., 2005), may activate valence effects in the cognitive tasks. The inclusion of the matching physical threat and physical positive words act as a control, as these words usually relates to attentional bias in anxiety (for example, Mathews & MacLeod, 1985), but it has not been studied widely in lonely people, to explore whether high lonely people demonstrate attentional bias when processing physical words may fulfil this gap.

Why Stroop and not the dot probe task? Another typical task applied to measure attentional bias is the dot-probe task. A dot probe task begins with a fixation mark displayed in the centre of the screen, followed by two valent or neutral words at the top and the bottom of the screen. After the 500ms of presentation, one of the stimuli is replaced by a probe. The participants are asked to press a button indicating whether the probe appeared at the top or the bottom of the screen (Cisler, Bacon, & Williams, 2009). A faster response to the probe indicates an attentional bias toward the emotional meaning of the word while a faster response to the probe appearing on the non-emotional word indicates an attentional bias to disengage from the threat (MacLeod et al., 1986). The dot-probe task has been used to demonstrate an attentional bias that disengages from threat amongst individuals with high state anxiety, high trait anxiety, generalized anxiety disorder and social phobia (Cisler et al., 2009).

The dot-probe task, however, is not without its critics. Because there is only one stimulus preceding the probe on each trial of testing, there is no competition for the attentional resources (Starzomaska, 2017). Thus, it has been argued that the dot-probe task may only measure the disengagement of attention rather than the bias towards threat (Cisler et al., 2009). The dot-probe task may therefore measure the presence of attentional bias, but it cannot distinguish between the vigilance and difficulties in disengagement from the threat (Koster et al., 2004).

Lonely individuals, who are argued to experience hypervigilance toward social threat might not experience difficulties to disengage from these threats. Therefore, for the current study, the Stroop task was used instead of the dot-probe task to measure attentional biases.

A Directed Forgetting paradigm. Individuals who feel lonely are argued to have maladaptive memory process compared with individuals who do not (Gardner et al., 2005). According to empirical research, individuals with a higher level of loneliness show a poorer ability in cognitive functioning, including immediate recall and delayed recall (Boss, Kang & Branson, 2015). Amongst breast cancer survivors, lonelier women report more concentration and memory problems than less lonely women (Jeremka et al., 2014). Memory function is also a factor that contributes to the development of loneliness – a lower level of memory functioning predicts a higher level of loneliness 4 years onwards but not the other way round (Ayalon, Shiovitz-Ezra & Roziner, 2016).

However, with most of the previous work using cognitive function measurements of lonely people, the only cognitive paradigm that has tested lonely individuals' memory bias found that high lonely individuals showed a heightened memory for social information. A study by Gardner et al. (2005) examined this directly by using a diary study and they concluded that lonely individuals are more likely to remember information that related to self, friends and couples. Spithoven (2017) in her review of loneliness and information processing, outlined that the memory bias may be an important factor that related to loneliness, but this area of research needed to be extended.

The current study used a Directed Forgetting paradigm (DF) to examine whether 1) lonely individuals tend to remember more social threat words and 2)

whether lonely individuals differ from non-lonely individuals in their forgetting of information they are instructed to forget. In a directed forgetting task, participants are presented with a series of words on a computer screen one after another. Immediately after each word appears, they see either an instruction of "RRRRRR" to remember, or "FFFFFF" to forget that item. After they studied all the words, participants are asked to recall all the words they can remember, despite the instructions to the contrary. Typically, participants exhibit a directed forgetting effect in that they recall more words followed by a remember instruction than words followed by a forget instruction.

According to one account, the words that the participants are instructed to forget are intentionally suppressed (for example, MacLeod, 1975; MacLeod, 1999; Korfine & Hooley, 2000). Prior research has shown that directed forgetting for emotional words may be much smaller than for neutral words, at least for special populations, and when the words participants are told to forget are related to the concerns of the participant (Cottencin et al., 2006; Korfine, & Hooley, 2000). Other studies, however, have shown that special populations can have a larger directed forgetting effect for emotionally negative items due to an avoidant or dissociative encoding style (for example, see Terr, 1994).

The DF task has been used to examine the recall and inhibition of irrelevant information in many clinical groups. Previous research findings showed that individuals tend to remember more self related words or find it difficult to forget the "forget" words (Korfine & Hooley, 2000). An "impaired directed forgetting" has been found in many clinical groups with emotional disorders. For example, individuals with Borderline Personality Disorder (BPD) showed a memory bias towards BPD related negative stimuli, with BPD individuals recalling more BPD symptoms words compared with non-BPD participants (Koefine & Hooley, 2000). People with PTSD also show a difficulty in forgetting trauma words during the DF task (Cottencin et al., 2006).

It was expected that lonely individuals, who are characterised by hypervigilant to rejection content in social context (Bangee & Qualter, 2018), and recalling more social information in a memory study (Gardner et al., 2005), may remember more social threat words than the other categories of words that were originally followed by a remember instruction in the current study.

Method

Participants

Seventy-seven students at the University of Central Lancashire and Cardiff Metropolitan University (sixty-three females) participated in return for £5 Amazon voucher and 6 course credits each. All were native English speakers and reported normal or corrected-to-normal vision and normal hearing. Participants were aged between 18 and 54 years old (M = 22.26, SD = 7.13). The same participants took part in all three tasks.

Questionnaire Measures

Revised UCLA loneliness scale (Russell et al., 1980). The UCLA Loneliness scale comprised 20-items for which participants were instructed to rate how often of each statement is a description of them. Each item scale measured "one's subjective feelings of loneliness as well as feelings of social isolation." Responses were ratings on a Likert scale from 1 (Never) to 4 (Often). The score range of the questionnaire is 20 to 80. Higher scores indicate a higher level of loneliness. Example items include "No one really knows me well", "I feel left out", and "I am unhappy being so withdrawn". Cronbach's alpha for the scale in the current study was 0.94.

Centre for epidemiologic studies depression scale (CES-D, Radloff, 1977). The CES-D scale is a 20-item scale designed to measure depressive symptomatology in the general population (Radloff, 1977). Participants were expected to score each item based on how often they felt that way during the past week. Each item was rated on a Likert scale range from 0 (Rarely or none of the time [less than 1 day] to 3 (Most or all of the time [5-7 days])). The range of scores for the questionnaire is 0 to 60. Higher scores suggest the presence of more depressive symptoms. Example items in this scale include: "I was bothered by things that usually don't bother me", "I felt that I could not shake off the blues even with help from my family or friends". Cronbach's alpha was 0.89 in the current study.

Brief fear of negative evaluation (Leary, 1983). The Brief Fear of Negative Evaluation is a 12-item scale that assesses the degree to which people are apprehensive about being evaluated negatively. Instructions of the scale asked

subjects to indicate how characteristic each statement describes of them. Participants respond to each item using a 5-point Likert scale from 1 (Not at all characteristic of me) to 5 (Extremely characteristic of me). The score range for the questionnaire is 12 to 60. Higher scores on the scale indicate a higher tendency to be apprehensive at the prospect of being evaluated negatively (Leary, 1983). Example items in the scale include "I worry about what other people will think of me even when I know it doesn't make any difference", "I am afraid that others will not approve of me". Cronbach's alpha was 0.92 in the current study.

Interaction anxiousness scale (Leary, 1983). The Interaction Anxiousness Scale measures the general tendencies of participants to experience anxious feelings in situations involving contingent social interactions (Leary, 1983). The Interaction Anxiousness Scale consists of 15 items, each item was measured on a 5 point Likert scale from 1 (Not at all characteristic of me) to 5 (Extremely characteristic of me). The score range of the scale is 15 to 75. Higher scores on the Interaction Anxiousness Scale indicate a higher level of social anxiety. Example items include "I often feel nervous even in casual get-togethers", "I wish I had more confidence in social situations", "I get nervous when I must talk to a teacher or boss". Cronbach's alpha was 0.86 in the current study.

General Materials

The current study used emotion words in the context of cognitive experiments to measure the effect of how lonely individuals react to emotional stimuli. Emotion words can either express or elicit an emotional state. These words are characterised by having a high arousal levels and have a high or low valence (Scott, O'Donnell, Leuthold & Sereno, 2009). How people process written emotion words is an important issue for word recognition as well as affective neuroscience (Scott, et al., 2009). The use of emotion words in studying individual's cognitive process in relation to emotional disorders is also widely used and effective (González-Garrido, Gómez-Velázquez, Sequeira, Ramos-Loyo & López-Franco, 2013). Five categories of words were selected for use in the experiments in this study: (1) neutral (e.g. sun, monsoon), (2) physical threat (e.g. pain, brutal), (3) physical positive (e.g. secure, free), (4) social threat (e.g. shy, hatred) and (5) social positive (e.g. love, confident). All the words belonging to the different categories

were matched for psycholinguistic factors including word length, Kucera-Francis written frequencies, Thorndike-Lorge written frequencies, number of letters, number of syllables, concreteness and the valence related to the social positive, social threat, physical positive, physical threat words. Words were selected from a variety of published studies including Korfine and Hooley (2000), Helfinstein, et al. (2008), Beck et al., (2011), Taake, Jaspers-Fayer, and Loitti (2009), Maidenberg, et al. (1996), Asmundson & Stein, (1994), Hope et al. (1990), Mansell and Clark (1999), Mathews et al. (1989), and Mansell et al. (2002). The online MRC Psycholinguistic Database, Version 2.0 (Informatics Division Science and Engineering Research Council Rutherford Appleton Laboratory Chilton, Wilson, 1987) was also used to search for, and compare, the psycholinguistic properties of the words selected. The properties of words used in the current study are shown in Appendix 4, Appendix 5 and Appendix 6.

Experiment Procedures

Serial Recall.

Materials. The experiment was executed using E-Prime 2.0 software (Psychology Software Tools, 2012) on a desktop computer or a laptop.

To-be-ignored auditory sequences. For the irrelevant auditory sequences, five sets of 40 spoken words in total were recorded in a female voice in an even pitch, and were digitally recorded at 44.1 kHz using 16-bit encoding. The five different streams of to-be-ignored auditory sequence were created by using neutral, social threat, social positive, physical threat and physical positive streams of words, as shown in Table 3.1. Each word was edited to last from range 598 msec (e.g. deer) to 928 msec (e.g. engage) and was normalised so as to minimise amplitude differences among the words in the software Audacity (Audacity Development Team, 2014). In each condition the presentation order of the words was random. The auditory sequences were presented at a sound level of approximately 65dB(A) over Sennheiser HD 202 headphones that participants wore in all conditions. A silent condition was also included in this task. For the silent sequence, no irrelevant speech was used.

Table 3.1. *To-be-ignored auditory speech sequences in the Serial Recall task*

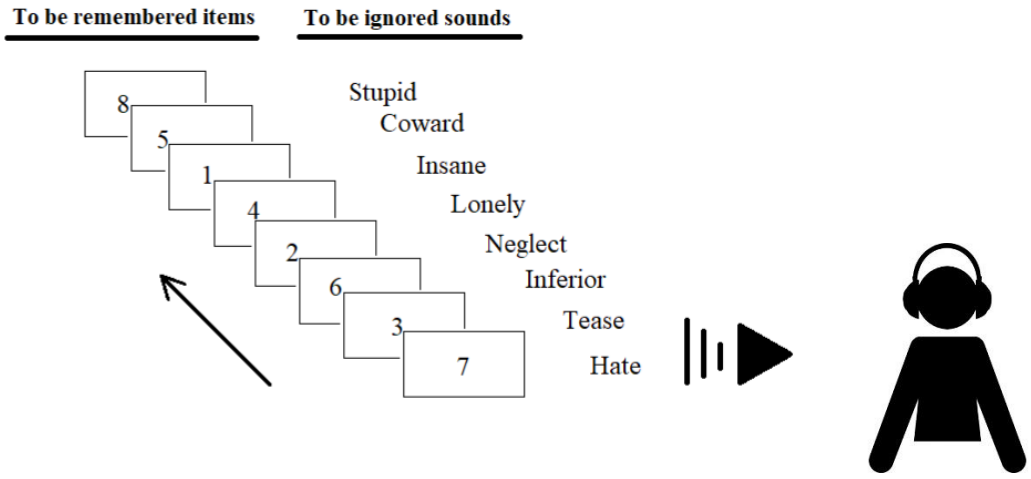
Neutral	Physical Threat	Social Threat	Physical Positive	Social Positive
badger	*assault*	*coward*	*carefree*	*admire*
deer	*cancer*	*hate*	*cuddle*	*engage*
donkey	*coffin*	*inferior*	*dazzle*	*gentle*
elephant	*damage*	*insane*	*greet*	*hope*
hamster	*hurt*	*lonely*	*protect*	*intimate*
rabbit	*mutilate*	*neglect*	*lively*	*loyal*
sheep	*pinch*	*stupid*	*safe*	*passion*
turtle	*robber*	*tease*	*secure*	*virtue*

Verbal serial recall task procedure. The visual to-be-remembered lists comprised eight digits drawn from the set *1-8.* These digits were sampled without replacement and were arranged in a quasi-random order with the constraint that there were no ascending or descending runs of more than two digits. These digits were presented in black Times New Roman font on a white background, one at a time, sequentially, in the central position of a computer display. The digits were presented for 350 msec each, with a 400 ms inter-stimulus interval. There were 90 trials in total: 15 of each condition. The onset of each to-be-ignored speech token coincided with the presentation of each to-be-remembered item. The length of the to-be-ignored sound was played based on the length of the words. Thus, the irrelevant sequence was presented synchronously with the visual sequence presentation.

Procedure. The task began with two practice trials performed in quiet prior to the block of 90 experimental trials. The procedure of each trial were shown in Figure 3.1 and 3.2. Participants initiated a trial by pressing the spacebar. For the visual-verbal serial recall task, 1000 msec after the presentation of the last item in each trial the mouse pointer appeared in the centre of the screen with all of the to-be-remembered digits and a question mark presented in a circle and arranged randomly. 8 empty response boxes were placed horizontally under the digits. Participants were required to reconstruct the order by using a mouse-driven pointer to click on the digits in the order they were presented. Once selected, a digit appeared in the response box. Once the participant had clicked on a digit, the response could not be changed. Participants could click the question mark if they could not recall a digit. Once the participant had recalled the whole sequence, the next trial began instantly.

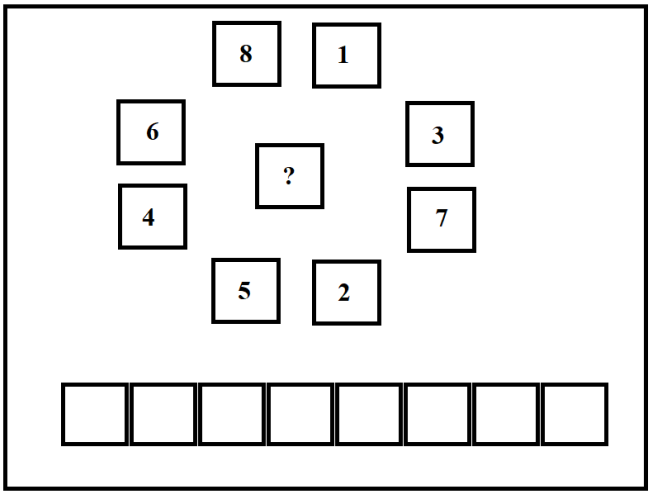
No sound was presented during the response stage of the tasks. The experiment lasted on average 40 minutes and participants were given a 2 minute break after completing 45 trials.

Figure 3.1 The procedure of Serial Recall task



Note: after starting each trial, participant hear 8 to-be-ignored words (social threat words, in this example), while been presented to 8 to-be-remembered digits. Each digits were presented with 350 msec, with a 400 ms inter-stimulus interval. The sound coinciding with the digits last the same length as each item.

Figure 3.2 The recall screen of the Serial Recall task



Note: After completed encoding the 8 digits, participants were diverted to the recall screen where they were required to retrieve the digits with the order they were

presented. If can cannot recall a digit they can click the question mark. Once a number is selected, it cannot be changed.

Emotional Stroop.

Procedure. The experiment was programmed in E-Prime 2.0 software that was executed on a desktop or laptop computer. Participants sat approximately 60 centimetres away from the screen. A microphone was connected to a serial response box which is registered to E-prime 2.0. Participants' speed of response was measured through the microphone via a voice-key. Therefore, reaction time was generated when the microphone detected a speech signal.

The experiment contained four blocks. Each block contained 50 words in total with 10 words each in neutral, social positive, social threat, physical positive and physical threat categories. There words were shown in Table 3.2. The same words were presented in the 4 blocks. In each block, words were pseudorandomised to prevent consecutive trials with the same response (colour name). Moreover, the order of the blocks was pseudorandomised to avoid consecutive presentation of blocks of the same valence. In total, subjects were exposed to 40 neutral, 40 social positive, 40 social threat, 40 physical threat and 40 physical positive words. Each word was written in lowercase letters and presented in red, yellow, green or blue. Each word was presented in a different colour in a different block. Therefore, all words were presented in each colour once.

Table 3.2. *The words used in the emotional Stroop task*

Neutral	Social Threat	Social Positive	Physical Threat	Physical Positive
Sun	*Shy*	*Pal*	*Hit*	*Hug*
Wind	*Fear*	*Love*	*Pain*	*Free*
Cloud	*Shame*	*Brave*	*Death*	*Smile*
Monsoon	*Jealous*	*Beloved*	*Torture*	*Glamour*
Winter	*Hatred*	*Polite*	*Brutal*	*Caress*
Temperate	*Embarrass*	*Confident*	*Ambulance*	*Beautiful*
Autumn	*Inferior*	*Passion*	*Assault*	*Secure*
Climate	*Neglect*	*Intimate*	*Mutilate*	*Protect*
Thunder	*Failure*	*Respect*	*Destroy*	*Healing*
Almanac	*Useless*	*Honesty*	*Funeral*	*Holiday*

For each trial, participants were presented with a question mark in the centre of the computer screen and were required to press the space bar to trigger the onset of a word. After pressing the space bar, participants would see a fixation mark that lasted for 500 msec, followed by the presentation of the test word. Each word was then presented for 3000 msec on the computer screen. Participants were instructed to name the colour as quickly and accurately as possible, and without attending to the word meaning. Once a response was detected, the word disappeared and was followed by a blank screen for 1000 msec after which the next trial began. The procedures of word display and the vocal response capture is correspond with Elliott et al. (2014). However, other studies, for example (Dresler, Mériau, Heekeren & van der Meer, 2009), used different display duration for words and blank screen which may have an impact on the results.

The procedure was continued until all the words had been presented to the participants. After each block was presented, participants were given a break for 2 minutes. Five practice trials comprising neutral words that were unrelated to the categories used in the task were presented to the participants to familiarise themselves with the task.

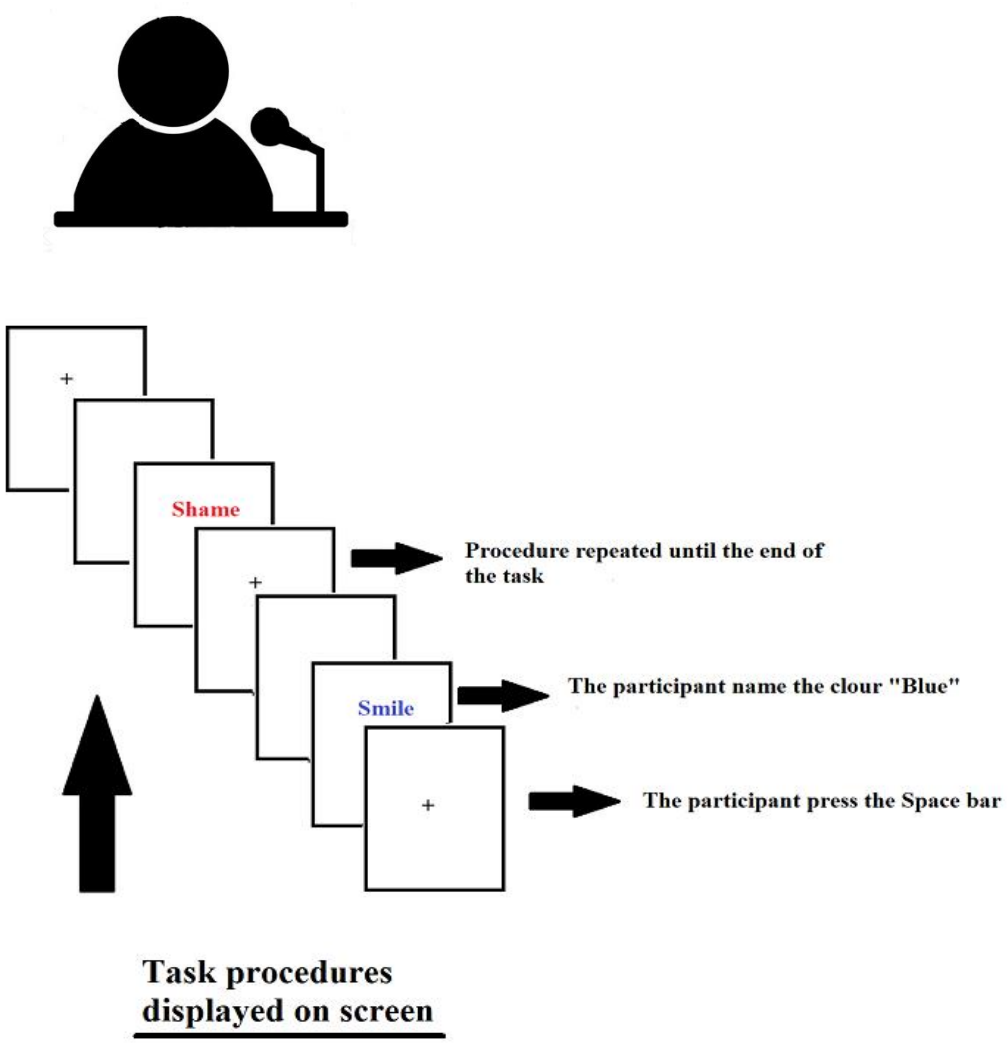


Figure 3.3 The emotional Stroop task procedure

Note: The task begins with participants press the space bar to trigger the presentation of a word, the word will be presented in either red, green, yellow or blue ink. Participants then name the colour of the word to the microphone as soon as possible. Once a response was detected, the word disappeared and was followed by a blank screen for 1000 msec after which the next trial began.

Directed forgetting task.

Apparatus. The experiment was run on a desktop computer or laptop running an *E-Prime 2.0* software in which the program was written. Each word was written in black 32 pt Arial font on a white background.

Recall phase.

Materials. Seventy words were randomly presented to participants, 35 of which were followed by a remember instruction (RRRRRR) and 35 were followed by a forget instruction (FFFFFF). As for the previous tasks, words used in the directed forgetting task belonged to the 5 categories: neutral, social threat, social positive, physical threat, and physical positive. Each of the categories contained 7 remember words and 7 forget words. The full list of words used in the study were presented in table 3.3. The words were pseudorandomised and presented to participants with the constraint that two words from the same category were not presented in succession and that not more than two consecutively presented words was followed by the same instruction. Six buffer words (not related to the five categories of words) were also introduced to the participants, three at the beginning of the task and three at the end of the task. The buffer words were all followed by a RRRRRR instruction but correct recall of these words was not counted during analysis of the data (see McNally, et al, 1998). This was done to eliminate the primacy and recency effects.

These buffer categories served two purposes: (a) reduction of list-related serial position effects on the 16 critical categories and (b) decoy test items immediately after list presentation.

Table 3.3. *The remember and forget words used in the recall task in the Directed Forgetting task*

Neutral	*Social Threat*	*Social Positive*	*Physical Threat*	*Physical Positive*
Remember				
Actor	*Idiot*	*Funny*	*Vomit*	*Agile*
Farmer	*Betray*	*Humour*	*Victim*	*Talent*
Author	*Guilty*	*Mature*	*Trauma*	*Wisdom*
Barber	*Offend*	*Honest*	*Bloody*	*Clever*
Teacher	*Failure*	*Justice*	*Illness*	*Freedom*
Engineer	*Immature*	*Romantic*	*Violence*	*Peaceful*
Athletics	*Obnoxious*	*Dignified*	*Infection*	*Affection*
Forget				
Baker	*Timid*	*Jolly*	*Ulcer*	*Relax*
Sailor	*Reject*	*Loving*	*Lethal*	*Active*
Lawyer	*Insult*	*Humane*	*Punish*	*Decent*
Waiter	*Deceit*	*Reward*	*Poison*	*Rescue*
Soldier	*Hostile*	*Respect*	*Destroy*	*Embrace*
Musician	*Ridicule*	*Grateful*	*Cemetery*	*Ambition*
Professor	*Ignorant*	*Impressed*	*Suffocate*	*Intellect*

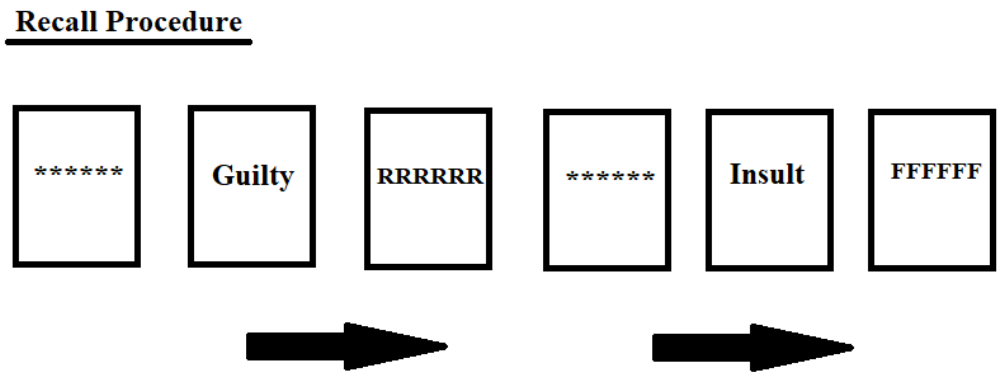
Procedure. Participants were told that 70 words were going to be presented to them. Each word was presented to the participants individually followed by an instruction. Participants were instructed to remember the words followed by a remember instruction (RRRRRR) only and to ignore the words followed by a forget instruction (FFFFFF). Prior to the experiment proper, they were given a 12-word practice list consisting of 6 remember and 6 forget words to familiarise themselves with the task.

In the practice task, each word and instruction was presented to the participant following the same procedure as the task itself. After studying all 12 words, participants were told to write down only the words which were followed by a remember cue. This was designed to reinforce the instruction to forget the forget words. When participants could not recall any more words, the researcher would explain that this is the end of the practice task and collect the papers.

After completing the practice trial, participants were then presented with the experimental list. The illustration of the procedure of the task were shown in Figure 3.4. For this each “trial” (comprising the presentation of a word and the instruction) began with the presentation of a 500 msec blank screen followed by a warning string

of six asterisks (******) for 1000 msec. After another 500-msec blank screen, a word appeared at the centre of the screen for 750 msec, followed by a 250-msec blank screen. The remember/forget instruction appeared after this for 2500 msec. The program then shifted to the next trial.

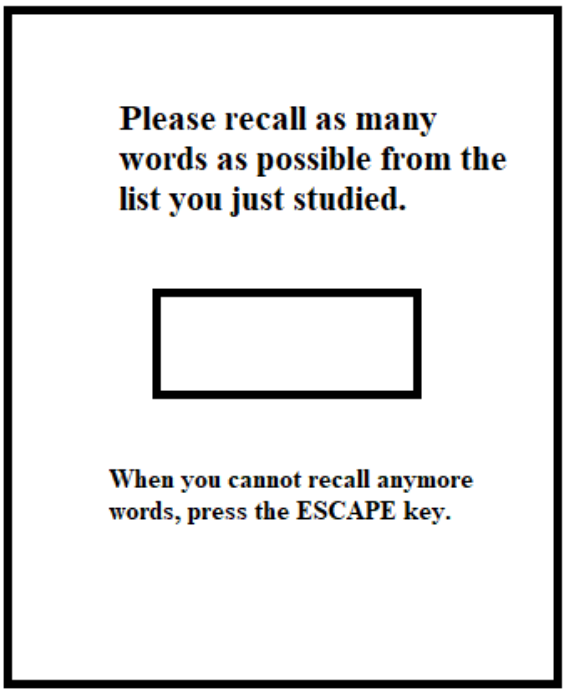
Figure 3.4 The encoding procedure of the Directed Forgetting task



Note: for this each word presented, a warning string of six asterisks (******) appeared for 1000msec, then a word appeared at the centre of the screen for 750msec, followed by the remember/forget instruction appeared for 2500 msec.

After studying all the words, participants were presented with a response box and instructed to recall as many words as possible, the recall screen appeared as Figure 3.5. At this stage, in contrast to the instructions on the practice trial, participants were instructed to also recall as many words as they could remember including the ones that they had been instructed to forget. When participants could not remember any more words, they were instructed to hit Escape on the keyboard in order to progress to the next phase of the study.

Figure 3.5 The recall screen of the Directed Forgetting task, participants were asked to recall all the words in the list regardless of instruction

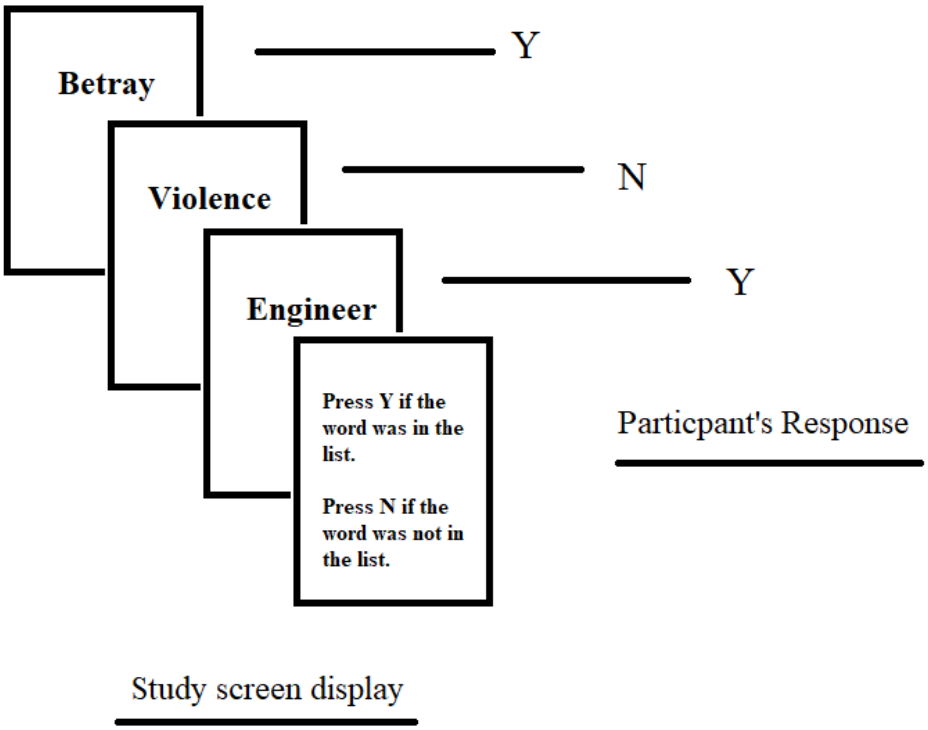


Recognition phase. After the recall study, participants were introduced to the recognition phase (see MacLeod, 1996). The Recognition phase involves re-present the learnt items in the mixture of matching new words to participants. Participants are expected to indicate whether the word has been presented to them in the recall stage regardless of the instruction it follows. The foil words are matching to words that have been viewed in terms of their written frequencies, valence, number of letters and number of syllables. The illustration of the recognition task were shown in Figure 3.6.

One of the interpretations of Directed Forgetting effect is the Intentional Inhibition theory, Geiselman and Bagheri (1985) suggested that the Forgets words were learned but inhibited during the recall phase, they could be released from inhibition when been exposed to these words.

The recognition task treats R words and F words as they represent a single category (Thompsom et al., 2011). On the one hand, if participants recognised an item correctly (remember or forget words), the items were encoded and learned. If participants give a No answer to a studied word, it implies the item were not encoded and learned (Sheard & MacLeod, 2005). Previous studies have demonstrated a directed forgetting effect in Recognition (for example, see MacLeod, 1975; MacLeod, 1999) whereby participants tend to recognise more R words than F words in the recognition phase.

Figure 3.6 The recognition procedure demonstration



Note. Participants press Y if they believe the word was presented in the recall phase, and press N if it was not.

On the other hand, if participants give a Yes response to a foil words, it could be due to two explanations: 1) participants conceives the item as a weakly encoded F words or a 2) strongly encoded R word (Thompson et al., 2011).

Here, another 70 foils, along with the original studied words (140 words in total), were presented to the participant. The foil words used in the Recognition task were shown in Table 3.4.

Each of the original words were paired with a corresponding word that was matched for word category, valence, number of letters, concreteness, frequency and number of syllables. This resulted in 70 new words that acted as “lure” material. Each of the categories therefore had 14 new words (resulting in 28 words per category). During the recognition phase, the studied words and new words were presented randomly.

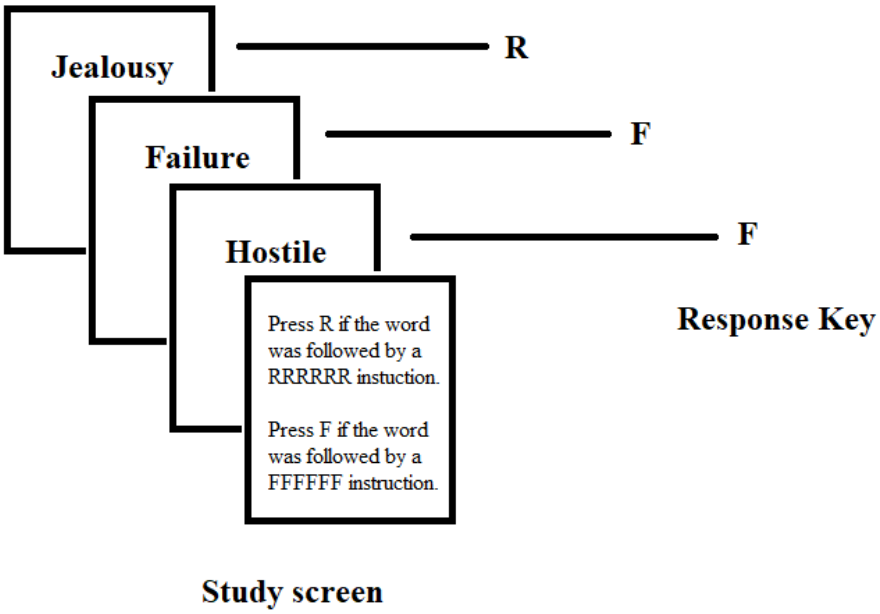
Table 3.4. *The matching foil words in the Directed Forgetting Recognition task*

Neutral	Social Threat	Social Positive	Physical Threat	Physical Positive
Pilot	*Timid*	*Amuse*	*Abuse*	*Witty*
Tutor	*Inept*	*Civil*	*Fever*	*Alive*
Banker	*Feeble*	*Genial*	*Crisis*	*Dainty*
Singer	*Malice*	*Favour*	*Injure*	*Genius*
Doctor	*Touchy*	*Plucky*	*Clinic*	*Timely*
Tailor	*Ignore*	*Kindly*	*Deadly*	*Tender*
Broker	*Wicked*	*Humble*	*Attack*	*Robust*
Golfer	*Menace*	*Mighty*	*Quiver*	*Superb*
Dentist	*Fearful*	*Delight*	*Exhaust*	*Healthy*
Butcher	*Despair*	*Sincere*	*Painful*	*Prosper*
Composer	*Jealousy*	*Sociable*	*Homicide*	*Valuable*
Mechanic	*Peculiar*	*Tolerant*	*Bacteria*	*Abundant*
Carpenter	*Depressed*	*Competent*	*Suffering*	*Fortunate*
Fisherman	*Criticise*	*Outgoing*	*Abduction*	*Authentic*

Each recognition trial began with a 500 msec blank screen followed by either a word that had been presented previously, or a lure word that had not, for 10000 msec. Participants were instructed to press “n” on the keyboard if they believed that the words had not been presented to them during the study and to press “y” on the keyboard if they thought the words were presented to them regardless of the instruction (i.e. Remember or Forget) that followed the words in the earlier study phase. Once the participant had made their response for a given word, the next trial began. If the give a response within the 10 seconds allotted, the next word would appear automatically and no response would be recorded for the previous trial.

Tagging phase. After completing the recognition test, instructions of the tagging phase were shown on screen (see Macleod, 1999). Participants were requested to indicate the instruction that followed each word they were presented with in the earlier study phase. The illustration of the Tagging task were shown in Figure 3.7. The tagging task provides extra information in addition to the recognition task. As there were no unstudied words in the Tagging phase and passing an answer was not permitted (participants have to respond either "R" (represent remember) or "F"(represent forget) to an item). If participants correctly tagged the R words, it suggests that the R words were learned and retrieved. A misattribution of an "F" to an R words suggests that the item was not very well learned. A correct tagging of the F words could be due to the participant having learnt the word and retrieved it, or it could also be down to chance (Macleod, 1999). Misattribution of a R cue to a F word could be due to poorer forgetting or failure of inhibition of certain F words. In this study, the particular interest was on whether lonely people remembered more Social Threat Remember words and were not able to forget (supress) the Social Threat Forget words.

Figure 3.7 The tagging phase of the Directed Forgetting task



The seventy words originally studied in the recall phase were presented to the participant individually. The trial began with a 500 msec blank screen followed by a word that stayed in the centre of the screen for 10000 msec. Participants were instructed to press the “r” key for a Remember word and “f” key for a Forget word. As soon as a response was given, the next trial began. If no response was given within the time frame, the next trial began automatically.

Results

Characteristics of the Study Group

Table 3.5 describes the characteristics of the study group and the distribution of loneliness scores. The mean loneliness in the current study is 39.89 (*SD* =9.95), which is in line with prior research suggesting that the mean scores of UCLA Loneliness Scale amongst western students is 40.08 (Russel, 1996). Therefore, the results are comparable with previous research. Moreover, university students aged between 18 to 29 (M_{age} = 20.36, *SD* = 2.83) scored lower on loneliness (*M* = 40.44, *SD* = 9.96) compared with individuals between the ages 30 to 54 (M_{age} = 33.67, *SD* = 8.09). The results are in line with previous research findings that loneliness distributed in a U-shape across age, with individuals under 25 and over 65 being the most lonely group (Victor & Yang, 2012). All participants have English as their first language and reported normal to correct-to-normal vision and normal hearing.

Table 3.5. *Social demographic characteristic and loneliness score in the current study*

	Number of Participants	Age	Loneliness Mean	SD
Whole sample	74	22.17(7.09)	39.89	9.95
Age (18-29)	66	20.36(2.83)	40.44	9.96
Age (30-54)	6	42.00(9.76)	33.67	8.09

Serial Recall Results

Proportions of correct responses. The data were scored according to the strict serial recall criterion: Responses were only recorded as correct if the recalled digit appeared in its original position of presentation at output. Performance was compared across the three loneliness groups computed as described in the foregoing.

Main effect. A 6 (Sound Condition) × 8 (Serial Position) repeated measures analysis of variance (ANOVA) revealed a significant main effect of the Sound Conditions, $F(5, 365) = 65.81$, $MSE = .056$, $p < .001$, $\eta p^2 = .474$ and Serial Position, $F(7, 511) = 166.32$, $MSE = .134$, $p < .001$, $\eta p^2 = .695$. The serial position graph in the current study were shown in Figure 3.8. Moreover, there was a significant interaction between Sound Condition and Serial Position, $F(35, 2555) = 2.30$, $MSE = .020$, $p = .001$, $\eta p^2 = .031$.

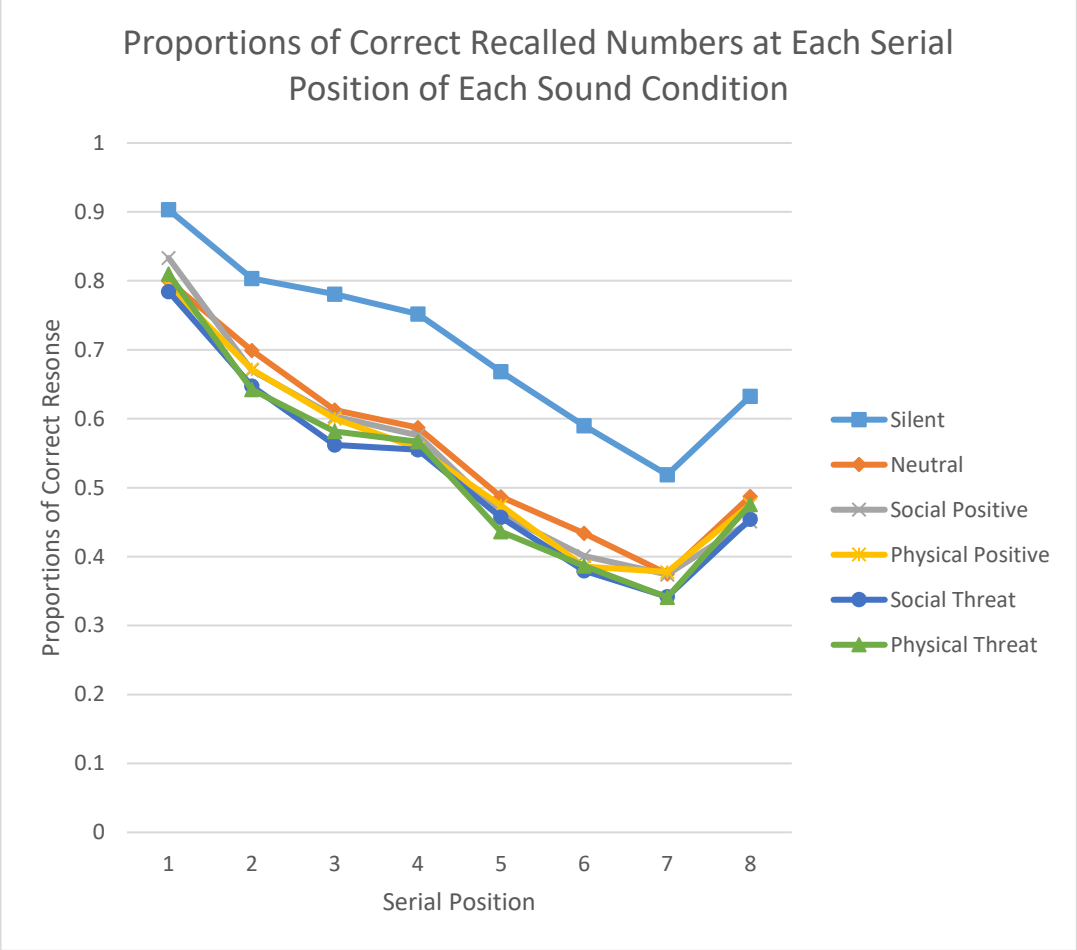
Orthogonal contrasts on the sound conditions were undertaken to test more specific hypotheses about the action of the different sound conditions on serial recall performance. The first orthogonal contrast showed that the difference between the silent condition and all other conditions combined was significant, $F(1, 71) = 82.79$, $MSE = .012$, $p < .001$, $\eta_p^2 = .538$. This confirmed that the typical irrelevant speech effect had been replicated.

Thereafter, orthogonal contrasts between Sound Conditions showed that Social Threat, $F(1, 71) = 5.56$, $MSE = .009$, $p = .021$, $\eta_p^2 = .073$ and Physical Threat stimuli, $F(1, 71) = 3.36$, $MSE = .010$, $p = .071$, one-tailed, $\eta_p^2 = .001$ were more disruptive than Neutral stimuli. Neutral stimuli did not differ in their effect on serial recall compared with Social Positive, $F(1, 71) = .95$, $MSE = .012$, $p = .334$, $\eta_p^2 = .013$ and Physical Positive stimuli, $F(1, 71) = .88$, $MSE = .011$, $p = .353$, $\eta_p^2 = .012$.

There were no differences in the effects of other word categories on serial recall performance. For example, there was no performance difference between Social threat and Physical Threat stimuli $F(1, 71) = .20$, $MSE = .006$, $p = .656$, $\eta_p^2 = .003$; Social Positive and Physical Positive stimuli, $F(1, 71) = .005$, $MSE = .009$, $p = .945$, $\eta_p^2 = .000$; Social Positive and Social Threat stimuli, $F(1, 71) = 1.72$, $MSE = .008$, $p = .194$, $\eta_p^2 = .024$; Social Positive and Physical Threat stimuli, $F(1, 71) = 1.06$, $MSE = .006$, $p = .307$, $\eta_p^2 = .015$; Physical Positive and Social Threat stimuli,

$F(1, 71) = 1.90$, $MSE = .008$, $p = .172$, $\eta_p^2 = .026$, and Physical Positive and Physical Threat stimuli, $F(1, 71) = .91$, $MSE = .008$, $p = .344$, $\eta_p^2 = .013$.

Figure 3.8 Serial Position Curves. The six plotted curves show the proportion of correct responses for serial recall with Silent conditions, Neutral conditions, Social Positive conditions, Physical Positive conditions, Social Threat conditions and Physical Threat conditions.



Note: as it showed on the serial position graph, participant's proportion of correct recall of digits at all serial positions in silent condition were higher than all the sound conditions. Within the sound conditions, Social Threat and Physical Threat were more disruptive than Neutral condition.

Results of the impact of loneliness. To examine the impact of loneliness on the digits recall under background speech, a series of linear and curvilinear regression analyses were undertaken. The regressions were run with the proportions of correct recall of items in each sound condition as dependent variable, and loneliness scores as independent variable. The results were shown in table 3.6. Results showed that loneliness was not a significant predictor of serial recall in silent

control condition (Linear: β=-.09, p=.425*; Curvilinear: β*=-1.29, p=.113), or causing more disruption in serial recall of other valent conditions, (beta weights for loneliness ranged from β=-1.57*, to* β=1.53, p>.05*]*). However, the curvilinear effects of loneliness on a better recall of digits for the Social Threat and Physical Threat condition were approaching significance (Social threat: Loneliness: β=-1.57, p=.073; Loneliness^2=1.53, p=.080; Physical Threat Loneliness: β=-1.46, p=.095; Loneliness^2=1.46, p=.095). The results suggest that loneliness may be associated with a better inhibition of the task irrelevant social threat and physical threat information. The curvilinear effects were shown in Figure 3.9 and Figure 3.10.

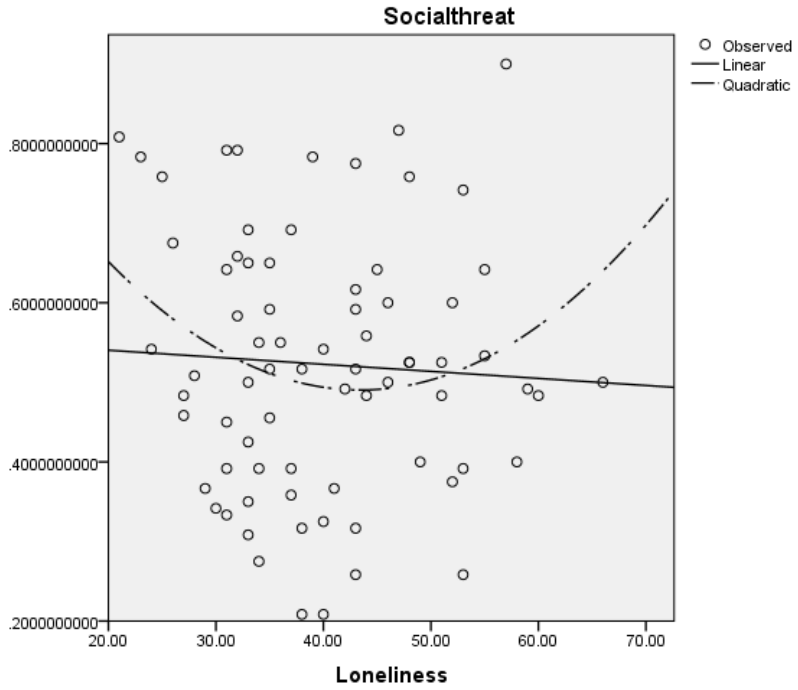
Table 3.6. *Results of Linear and Curvilinear regression of the Serial Recall task, the effect of loneliness on the proportion of correct response in each sound categories (N=74)*

	Silent			Neutral			Physical Threat			Physical Positive			Social Threat			Social Positive		
	B	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*
								Linear Regression										
Loneliness	-.002	.002	-.09	-.001	.002	-.08	.000	.002	-.01	.000	.002	-.01	-.001	.002	-.05	-.001	.002	-.05
								Curvilinear Regression										
Loneliness	-.02	.02	-1.29	-.02	.01	-1.45	**-.02**	**.01**	**-1.46***	-.02	.02	-1.32	**-.03**	**.01**	**-1.57***	-.02	.02	-1.37
Loneliness^2	.000	.000	1.20	.000	.000	1.39	**.000**	**.000**	**1.46***	.000	.000	1.32	**.000**	**.000**	**1.53***	.000	.000	1.33

*p<.05, **p<.01, ***p<.001

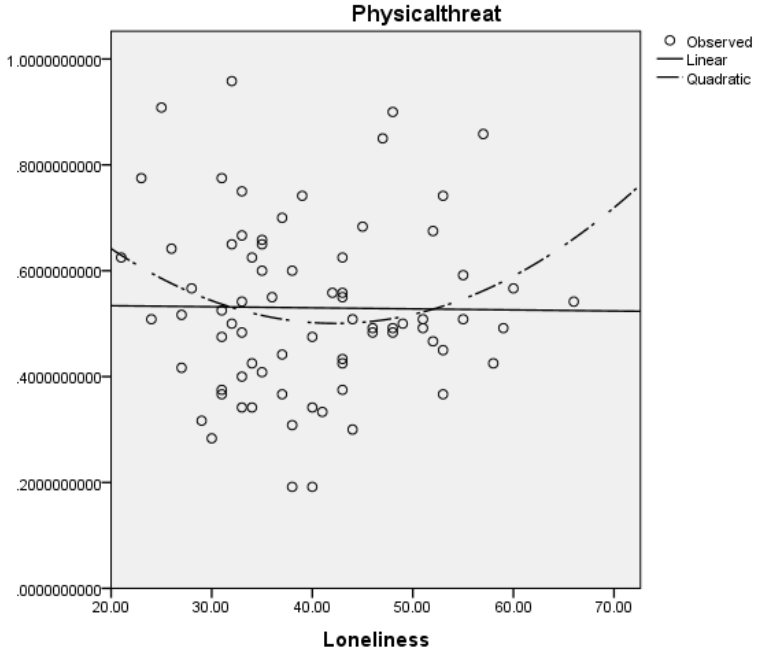
Note: the effect of loneliness on the proportion of correct recall of digits for the Social Threat and Physical Threat were approaching significance, suggesting a higher level of loneliness is associated with a better recall of digits when hearing social threat and physical threat sounds. (One-tailed)

Figure 3.9 The curvilinear regression of loneliness on the serial recall for social threat condition



Note: The curvilinear effect indicate that a higher level of loneliness is associated with a better recall of digits for the social threat condition.

Figure 3.10 The curvilinear regression of loneliness on the serial recall for physical threat condition



Note: The curvilinear effect indicate that a higher level of loneliness is associated with a better recall of digits for the physical threat condition.

Summary of Results

To summarise, the differences in performance on the serial recall task was driven by the disruptive effect of sound conditions and serial positions. The results replicate the irrelevant speech effect, showing performance of serial recall is impaired by task-irrelevant background speech (e.g., Buchner et al., 2004). The results showed that, for all participants, serial recall performance in the Silent condition was better than all sound conditions combined. Of the sound conditions, Social Threat words were more disruptive than Social Positive words. Other sound conditions did not differ in the extent to which they disrupted serial recall.

The results showed that loneliness did not contribute to the serial recall in silent, neutral or positive sounds condition. However, a higher level of loneliness is associated with a better recall of Social Threat and Physical Threat sounds condition, suggesting lonely individuals are not more distractible in these conditions compare with non-lonely individuals.

Emotional Stroop Results

Reaction time data. For Emotional Stroop data, the reaction time taken for participants to name the colour of words was computed individually for each category of word. The reaction times for the emotional Stroop task were calculated for each categories of words followed by the common RTs calculation procedures (Besner, Stolz & Boutilier, 1997; Gul & Humphreys, 2015; & Liu et al. 2015). The calculation of mean RTs excluded data from the incorrect trials (Neutral 14, Physical Positive 12, Physical Threat 19, Social Positive 20, and Social Threat 22) which accounted for 0.06% of the data. The outlier trials (more than 2.5 standard deviations from the mean) were deleted thereafter (Neutral 82, Physical Positive 93, Physical Threat 74, Social Positive 71, and Social Threat 76), and this accounted for 2.7% of the whole sample.

Main effects. The means and standard deviation of reaction times for colour naming of each category of words were shown in Table 3.7. A repeated measure analysis of variance (ANOVA) of the inversed reaction time taken to colour name each word in each category was carried out to examine effects of Word content (within-subject variable). The results showed a significant main effect of Word Category, $F(4, 288) = 5.02$, $MSE = 449.92$, $p = .001$, $\eta_p^2 = .065$.

Table 3.7. *Means and Std. Deviations of reaction time (in milliseconds) for each of the word categories*

Reaction Time	*Mean*	*SD*
Neutral	678.91	13.73
Physical Positive	665.29	12.93
Physical Threat	667.85	13.51
Social Positive	667.06	13.19
Social Threat	673.15	13.83

Orthogonal contrasts analyses showed that Neutral words (*M*=678.91, *SD*=13.73) were named slower than Physical Positive words (*M*=665.29, *SD*=12.93), $F(1, 72) = 16.26$, $MSE = 832.64$, $p < .001$, $\eta_p^2 = .184$, Physical Threat words (*M*=667.06, *SD*=13.19), $F(1, 72) = 10.37$, $MSE = 861.44$, $p = .002$, $\eta_p^2 = .126$, and Social Positive words, $F(1, 72) = 2535.57$, $MSE = 52157.70$, $p < .001$, $\eta_p^2 = .972$. The latency of naming Neutral words was not different from the latency of naming Social Threat words (*M*=667.06, *SD*=13.19), $F(1, 72) = .51$, $MSE = 945.76$, $p = .479$, $\eta_p^2 = .007$. The results demonstrated the "slow effect" of the emotional Stroop task (Phaf & Kan, 2007), that neutral words were named slower than the emotional words.

However, Social Threat words were named slower than Physical Positive words, $F(1, 72) = 4.14$, $MSE = 1090.85$, $p = .046$, $\eta_p^2 = .054$; and Social Positive words (*M*=678.91, *SD*=13.73), $F(1, 72) = 3.31$, $MSE = 819.06$, $p = .073$, $\eta_p^2 = .044$.

The next series of contrast analyses showed that there were no significant differences between the latency of colour naming of the other categories of words. There were no significant contrasts between Physical Positive words and Physical Threat words, $F(1, 72) = .51$, $MSE = 945.86$, $p = .479$, $\eta_p^2 = .007$. Physical Positive and Social Positive, $F(1, 72) = .29$, $MSE = 791.30$, $p = .594$, $\eta_p^2 = .004$; Physical

Threat and Social Positive, $F(1, 72) = .06$, $MSE = 794.53$, $p = .810$, $\eta_p^2 = .001$, and Physical Threat and Social Threat, $F(1, 72) = 1.69$, $MSE = 1216.38$, $p = .198$, $\eta_p^2 = .023$.

Loneliness results. A series of linear and curvilinear analyses were conducted with participants' loneliness scores as the independent variable and reaction time of naming each of the categories of words as dependent variables. The summary of results were shown in table 3.7. The results showed that there was a positive curvilinear effect of loneliness on the reaction time of naming Neutral words ($\beta = 1.53$, $p = .074$*, one-tailed), Physical Positive words ($\beta = 1.81$, $p = .035$*), Physical Threat ($\beta = -1.58$, $p = .067$*, one-tailed) Social Threat words ($\beta = .16$, $p = .058$*, one-tailed) and Social Positive words ($\beta = 1.59$, $p = .064$, one-tailed). The results indicated that individuals with a higher level of loneliness scores tended to take longer in naming the colour of all words. Although, the results are based on one-tailed statistical significance, according to previous research, lonely individuals show implicit attentional biases when completing the social Stroop task (Cacioppo, et al., 2015), thus the current study draw the hypotheses based on the findings of Cacioppo et al.'s study, that high lonely individuals will be slower at naming the colour of all words in the current study. Therefore, the one-tailed results were accept and interpreted.

The pattern of the U-shaped curvilinear results, as shown in figure 3.11, indicate a slower attentional regulation when processing visually presented stimuli. According to Cacioppo (2000), participants with higher loneliness scores tended to favour a bottom-up processing style, and words with valence may capture their attention automatically, resulting in a longer processing speed.

A linear and curvilinear regression was also run on the effect of loneliness on the number of errors made in each categories of words. The results were shown in Table 3.8a and Table 3.8b. The results showed that individuals with a higher loneliness scores made more errors when naming the Neutral ($\beta=.35$, $p=.003$**), Physical Positive ($\beta=.25$, $p=.035$*) and Social Positive words ($\beta=.28$, $p=.018$*). These results indicate that although individuals with a higher loneliness scores spend longer in naming the colour of all categories of words in the emotional Stroop task, this did not improve their response accuracy. A high error rates in the emotional

Stroop task is considered to be related to impulsive behaviour, whereas the latency is associated with inhibitory control processes (Eschenbeck et al., 2004). The findings from the original Stroop task suggest that dysfunctional impulsivity is associated with error rates (Brunas-Wagstaff, Bergquist & Wagstaff, 1994). It is possible that individuals with a higher level of loneliness, deployed most of their attentional resources on correctly naming the colour of the Social Threat and Physical Threat words, therefore resulting in a poorer accuracy in naming the Neutral, Social Positive and Physical Positive words, and a longer colour naming latencies for all words.

Summary of Results

Findings from the Emotional Stroop task failed to replicate the standard emotional Stroop effect. The emotional Stroop interference effect occurs when the semantic properties of the valent word impairs participant's processing of the task and results in longer reaction times (for example, see Williams, Mathews & Macleod, 1996). In contrast to the Emotional Stroop effect, in this study, the neutral words were named slower than all of the emotional words.

Critically, loneliness was a significant predictor of the reaction time of naming the colour of words in all categories. Moreover, loneliness was a significant predictor of errors made in naming the neutral words and positive words. The results suggested that individuals with a higher level of loneliness showed poorer attentional regulation, and favour the processing of negative information.

Table 3.8a. *The results of the linear and curvilinear regression of the effect of loneliness on the reaction time in naming the colour of each word category in the Emotional Stroop task*

	Neutral			Physical Threat			Physical Positive			Social Threat			Social Positive		
	B	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*
							Linear Regression								
Loneliness	-2.18	1.39	-.18	-2.12	1.37	-.18	-1.52	1.32	-.14	-1.68	1.41	-.14	-1.64	1.34	-.14
							Curvilinear Regression								
Loneliness	**-20.19**	**10.01**	**-1.70***	**-18.43**	**9.90**	**-1.58***	**-21.59**	**9.42**	**-1.93***	**-21.04**	**10.13**	**-1.76***	**-19.66**	**9.67**	**-1.72***
Loneliness^2	**.22**	**.12**	**1.53***	.20	.12	1.41	**.24**	**.11**	**1.81***	.23	.12	1.63	.22	.12	1.59

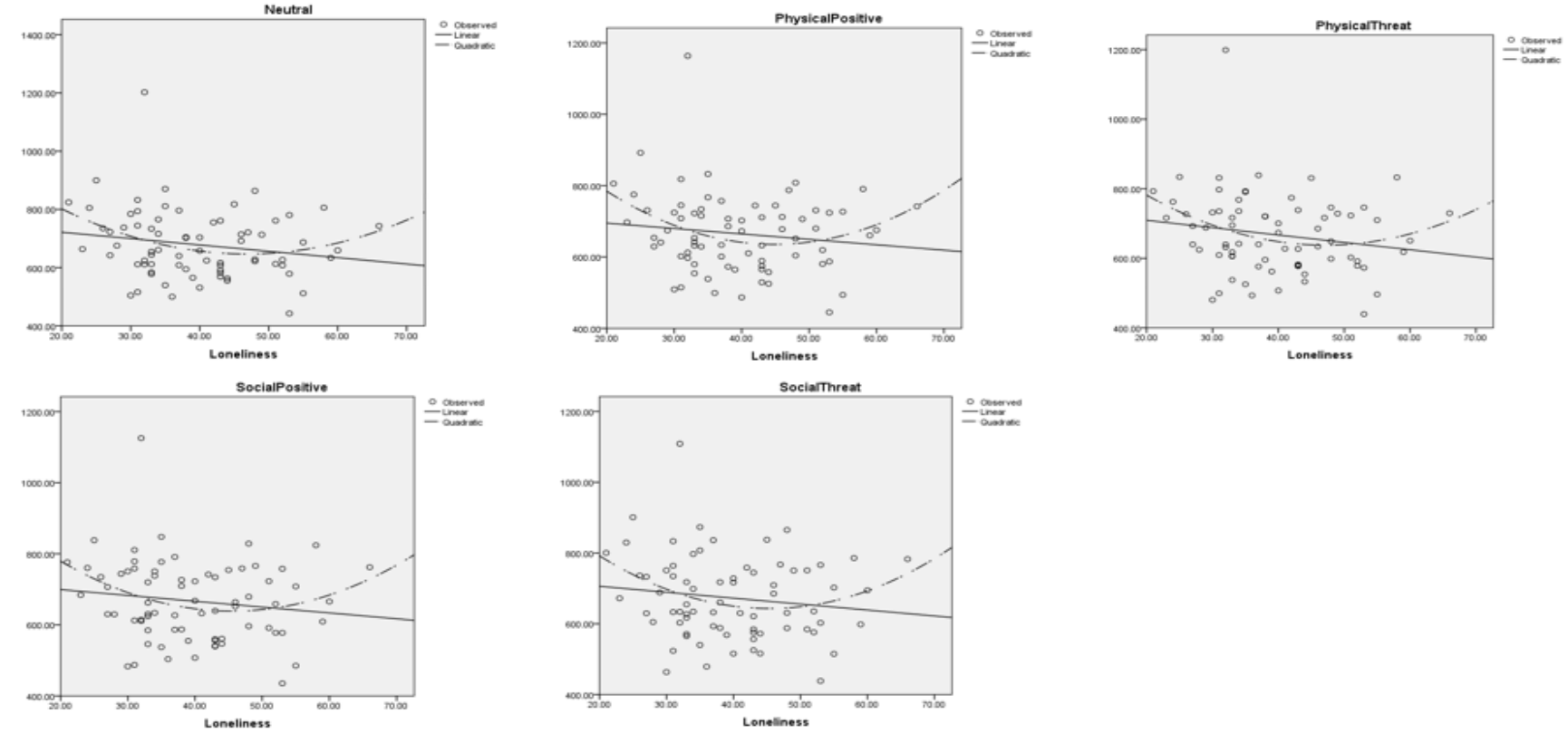
Notes: N=73, *p <.05, **p <.01, ***p <.001. The results suggested that loneliness is a significant predictor of a longer colour naming latency in all words (Neutral, Physical Threat, Physical Positive, Social Threat and Social Positive).

Table 3.8b. *The linear and curvilinear regression results of the Emotional Stroop Error analyses, with loneliness as independent variable, and the errors of colour naming when naming each category of words as dependent variable.*

	Neutral			Physical Threat			Physical Positive			Social Threat			Social Positive		
	B	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*
							Linear Regression								
Loneliness	**.02**	**.01**	**.35****	.01	.01	.15	**.01**	**.01**	**.25***	.01	.01	.06	**.02**	**.01**	**.28***
							Curvilinear Regression								
Loneliness	-.04	.04	-.69	.05	.05	.85	.01	.04	.26	-.03	.07	-.40	.03	.06	.40
Loneliness^2	.001	.001	1.05	.000	.001	-.71	.000	.001	-.02	.000	.001	.47	.000	.001	-.13

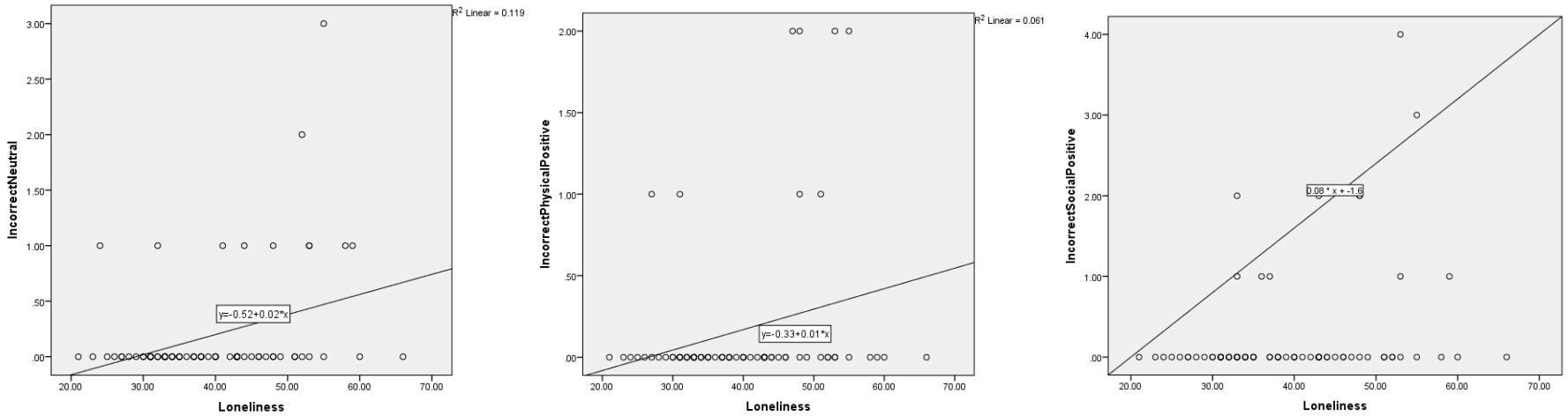
Note: N = 73, **P* < .05, ***P* < .01, ****P* < .001, the results suggest that a higher level of loneliness is associated with poorer accuracy of naming the Neutral, Physical Positive and Social Positive words.

Figure 3.11 The curvilinear regression graph of the emotional Stroop task, with loneliness as independent variable (axis X), reaction time of naming the colour of Neutral, Social Positive, Social Threat, Physical Positive and Physical Threat words as dependent variable (axis Y).



Note: The U-shape regression results showed that loneliness predicted a longer reaction time in naming the colour of all words.

Figure 3.12 The linear regression analyses of the errors made in the emotional Stroop task, with loneliness as independent variable (axis X), errors of naming the colour of Neutral, Social Positive and Physical Positive words as dependent variable (axis Y).



Note: The linear regression results showed that loneliness predicted a higher level of predicted more errors in naming the colour of Neutral, Physical Positive and Social Positive words.

Directed Forgetting Task

Recall phase.

Scoring of recall. The proportion of words remembered for the five word categories (Neutral, Social Threat, Social Positive, Physical Threat, and Physical Positive) in the two instruction conditions (Remember and Forget) was computed. The results were shown in Table 3.9. The hit rate of recall was calculated as follows: the number of correctly recalled words in an instruction (Remember or Forget) /total number of words in this category followed by a Remember or Forget instruction (7 Remember words and 7 Forget word in each word category). For example, if a participant recalled 4 Social Threat Remember words and 2 Social Threat Forget words, then participants' proportion of correct recall of social threat remember words would be 4/7 and their proportion of correct recall of social threat forget words would be 2/7.

Table 3.9. *The Mean and Standard Deviation of the proportions of correct recall of Remember and Forget words for Neutral, Physical Threat, Physical Positive, Social Threat and Social Positive words in the Directed Forgetting task*

Word Category		*Mean*	*SD*
Neutral	*Remember*	*.36*	*.024*
	Forget	*.06*	*.013*
Physical Threat	*Remember*	*.33*	*.022*
	Forget	*.02*	*.006*
Physical Positive	*Remember*	*.23*	*.020*
	Forget	*.02*	*.005*
Social Threat	*Remember*	*.27*	*.020*
	Forget	*.05*	*.010*
Social Positive	*Remember*	*.30*	*.021*
	Forget	*.04*	*.008*

Note: For each word category, the correct recall of Remember words were significantly higher than the recall of Forget words, which replicates the typical directed forgetting effect.

Proportion of words recalled for each word category. A 5 (Word Category) × 2 (Instruction) mixed analysis of variance (ANOVA) was carried out to examine whether Word Category and Instruction have an impact on recall performance in the directed forgetting task.

This analysis revealed a significant main effect of Instructions, $F(1, 73) = 356.55$, $MSE = .036$, $p < .001$, $\eta_p^2 = .830$, thereby demonstrating a typical directed

forgetting effect: participants recalled more words followed by the Remember instruction than the Forget instruction. A main effect for Word Category also emerged, $F(4, 292) = 10.53$, $MSE = .02$, $p < .001$, $\eta_p^2 = .126$. Pairwise comparisons showed that participants recalled more Neutral words than Physical Positive words ($p < .001$, $CI_{.95} = -.009, .086$), more Neutral words than Social Threat words ($p = .023$, $CI_{.95} = .004, .091$) and more Neutral words than Social Positive words ($p = .072$, $CI_{.95} = -.002, .091$).

For the words containing emotional valence, participants recalled more Physical Threat words than Physical Positive words, ($p = .001$, $CI_{.95} = .016, .088$), and more Social threat words than Physical Positive words ($p = .020$, $CI_{.95} = -.083, -.004$). Moreover, participants recalled more Social Positive than Physical Positive words ($p = .002$, $CI_{.95} = -.081, -.012$).

There were no differences between the recall of Neutral and Physical Threat words, ($p = .21$, $CI_{.95} = -.009, .086$); or between Social Threat and Social Positive words, ($p = 1.00$, $CI_{.95} = -.039, .033$).

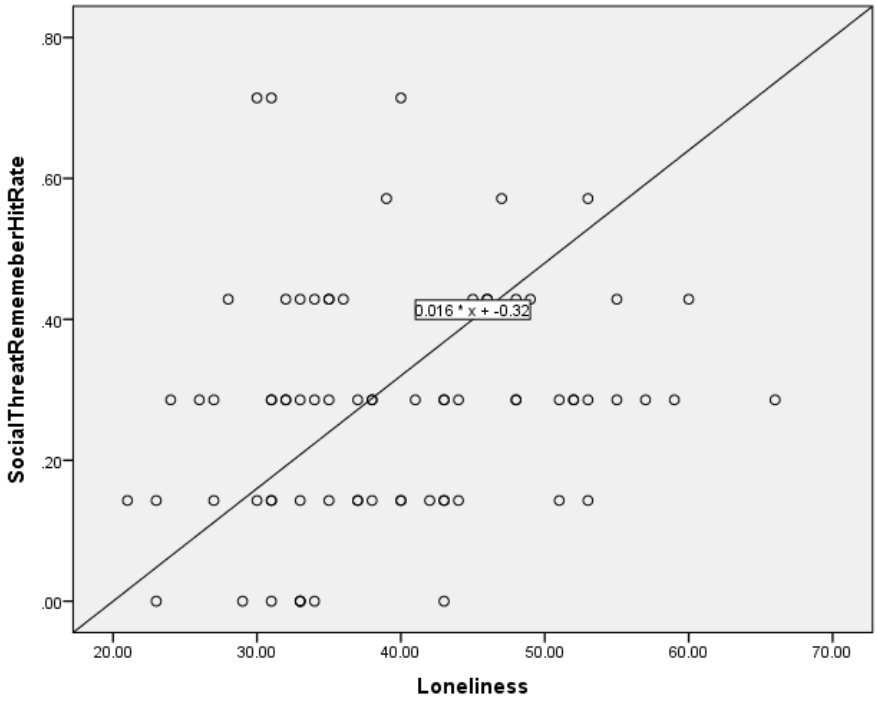
There was a significant interaction between Word Category × Instruction, $F(4, 292) = 5.49$, $MSE = .02$, $p < .001$, $\eta_p^2 = .070$. Simple effect analyses (Bonferroni corrected) showed that the interaction was driven by the recall performance of remember words, which was better than forget words in all five word categories: Neutral ($p < .001$, $CI_{.95} = .254, .353$), Physical Threat ($p < .001$, $CI_{.95} = .271, .358$), Physical Positive ($p < .001$, $CI_{.95} = .169, .252$), Social Threat ($p < .001$, $CI_{.95} = .175, .266$), Social Positive ($p < .001$, $CI_{.95} = .219, .310$).

For the effect of Word Category, simple effects analyses (LSD) showed that the recall of Neutral Remember words was better than the recall of Physical Positive Remember words, ($p < .001$, $CI_{.95} = .063, .211$), and Social Threat Remember words ($p = .013$, $CI_{.95} = .012, .166$). The recall of Physical Threat Remember words was better than the recall of Physical Positive Remember words ($p < .001$, $CI_{.95} = .038, .170$). For Forget words, there is a significant difference between the recall of Neutral Forget words and the recall of Physical Threat Forget words ($p = .007$, $CI_{.95} = .008, .081$) and between Neutral Forget words and Physical Positive Forget words ($p = .022$, $CI_{.95} = .004, .085$). Participants also recalled more Social Threat Forget

words than Physical Threat Forget words (p = .006, $CI_{.95}$ = -.070, -.007) and Physical Positive Forget words (p = .009, $CI_{.95}$ = -.071, -.006). There was no significant effect between the recall of other categories of words in either the Remember or Forget instruction.

Results of loneliness. To examine whether loneliness predicts the recall of the Remember and Forget words, a series of linear and curvilinear regression were undertaken, with participants' loneliness score as the independent variable and the proportion of words recalled in each category as dependent variables. The results showed that loneliness is a significant predictor of the proportion of Social Threat Remember words recalled in the Directed Forgetting task (β=.21, p=.070, one-tailed), but not any of the other categories of words with either Remember or Forget instructions. The linear regression graph were shown in Figure 3.13. The results suggested that individuals with higher loneliness tended to demonstrate a memory bias that favours Social Threat information. There was no significant effect of loneliness on the recall of Forget words, suggesting an intact forget mechanism of individuals with a higher level of loneliness.

Figure 3.13 The linear regression analyses results of loneliness and the proportion of correct recall of Social Threat Remember words.



Note. The results suggest that loneliness predicted a better recall of Social Threat Remember words in the Directed Forgetting task.

Recognition.

Scoring of recognition. In the recognition task, participants were presented with foil words that were similar to the learned information (drawn from the same categories). The participants were required to make a decision as to whether the word had been presented during the study phase, or not. The decision making of the uncertainty as to whether a word was presented has a cognitive component that is rooted in signal detection theory. Signal detection theory is used (primarily) in psychology for making inferences from data involving decision-making in the light of uncertainty (for example, see Abdi, 2007). The illustration of the signal detection theory are shown in Table 3.10.

Based on the Signal Detection Theory, four outcomes can occur after a word was presented. If a word is presented to participants in the recall task, regardless of the instruction that followed, participants would give a "Yes" answer if they believe these words were presented to them before, and give an "No" answer if they believe that the words were not previously presented. The outcomes were summarised as “Hits” and “Misses”. If a lure word was presented to them, the participant would answer "Yes" or "No" depending on whether they believe that they had seen the words before. The responses to the lure words were summarised as False Alarm and Correct Rejections in respect of the answer “Yes” and “No”. For example, if participant gave the answer “Yes” to the word “Betray”, which has been studied in the encoding stage, it would be counted as a Hit. If participant answered “No” to the word “Fearful”, which has not been studied in the encoding stage, it would be counted as “Correct Rejection”. The full word list used in the Directed Forgetting task were shown in Table 3.3 and 3.4. A total number of Hits, Misses, False Alarms and Correct Rejections was recorded and used for analysis.

Table 3.10. *The illustration of Signal detection theory*

	Respond present	*Respond absent*
Words present	*Hit*	*Miss*
Words absent (matching word)	*False Alarm*	*Correct Rejection*

d' prime and c'. In recognition tasks, participants respond "Yes" or "No" throughout the whole task. As a result, in the case of the "Yes" answer, only the words seen previously will be marked as correct and in the case of the "No" answer only the words not previously seen will be marked as correct. Moreover, participants could reject every word that they were not sure about and only respond "Yes" to the words that they were sure about or vice versa (Macmillan & Creelman, 1991). To avoid this effect, d' prime—which measures the broad sensitivity of detecting a signal—and c' response bias were calculated using the Hit and False Alarm rates for words in each of the categories followed by the remember or forget instructions. The formulae adopted for calculating d' and c are:

Sensitivity: d'= z (H)-z (FA) and

Response bias: c' = -0.5[z (H) + z (FA)]

(H refers to Hit rate and FA refers to False Alarm rate)

(Harvey, 2003)

A greater score of d' suggests a better performance (e.g., greater sensitivity) in recognition. Negative c indicates a bias towards a "Yes" response and positive c indicates a bias towards a "No" response.

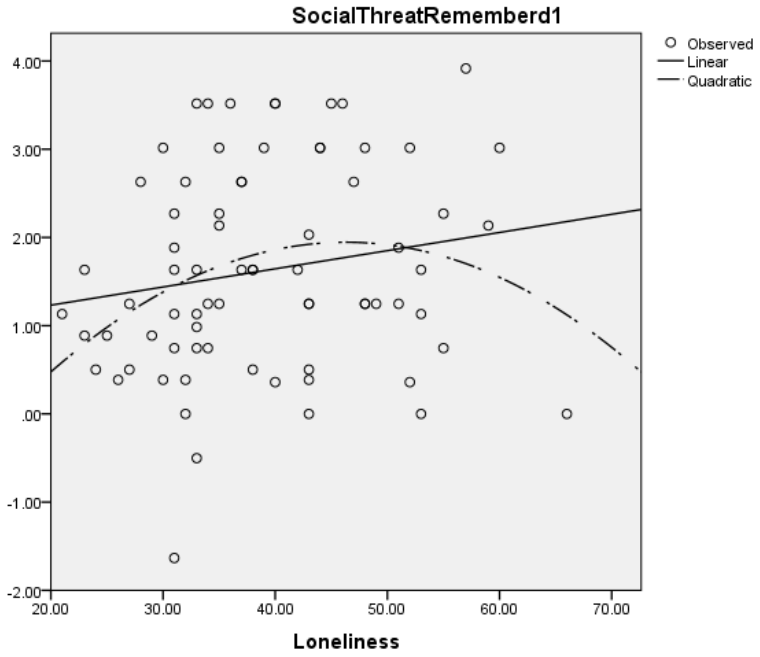
Main effect. For recognition sensitivity data (d' prime), two mixed ANOVAs were carried out on d' prime data, one for each condition (Remember and Forget).

For Remember conditions, a significant main effect of Word Category emerged, $F(4, 292) = 3.88$, $MSE = .73$, $p = .004$, $\eta_p^2 = .050$. Planned contrasts showed that (for Remember conditions) participants recognised Neutral Words ($M = 1.86$, *Std. Error* = 1.14) more poorly than Physical Threat words ($M = 2.13$, *Std. Error* = 1.13), $F(1, 73) = 3.70$, $MSE = 1.49$, $p = .058$, $\eta_p^2 = .048$. Moreover, all participants recognised Physical Threat words better than Social Threat words, $F(1, 73) = 12.41$, $MSE = 1.53$, $p = .001$, $\eta_p^2 = .145$. Participants recognised more Physical Positive words than Social Threat words, $F(1, 73) = 7.77$, $MSE = 1.59$, $p = .007$, $\eta_p^2 = .096$. Finally, Social Positive words were recognised better than Social Threat words, $F(1, 73) = 6.20$, $MSE = 1.61$, $p = .015$, $\eta_p^2 = .078$.

In the Forget condition, there were significant main effects for Word Category, $F(4, 292) = 2.59$, $MSE = .71$, $p = .037$, $\eta_p^2 = .034$. Planned contrasts showed that Neutral Forget words were recognised better than Physical Threat Forget words, $F(1, 73) = 11.23$, $MSE = 1.22$, $p = .001$, $\eta_p^2 = .133$ and Social Positive Forget words, $F(1, 73) = 2.91$, $MSE = 1.39$, $p = .092$, $\eta_p^2 = .038$, one-tailed. Physical Positive Forget words were recognised better than Physical Threat Forget words, $F(1, 73) = 5.26$, $MSE = 1.03$, $p = .025$, $\eta_p^2 = .067$. Social Threat Forget words were recognised better than Physical Threat Forget words, $F(1, 73) = 5.18$, $MSE = 1.25$, $p = .026$, $\eta_p^2 = .066$.

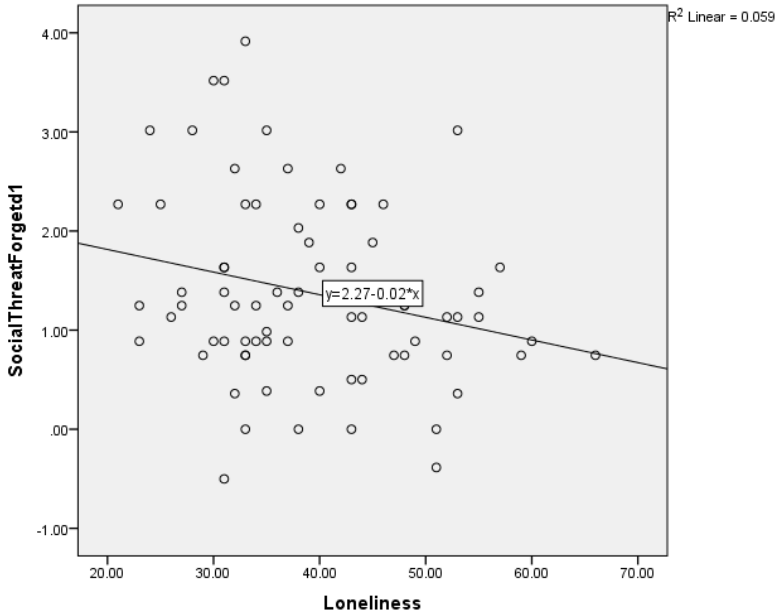
Results of loneliness. A series of linear and curvilinear regression analyses were undertaken to examine the impact of loneliness on the recognition of each categories of words. The independent variable is loneliness, the recognition accuracy (*d'*) in each word category are the dependent variables in each analysis. The results showed that, loneliness is a significant predictor of the recognition of Social Threat Remember words, (curvilinear: Loneliness, $\beta = 1.67$, $p = .048$; Loneliness^2, $\beta = -1.51$, $p = .073$), see Figure 3.14. Moreover, loneliness is a significant predictor for the recognition of Social Threat Forget words, (linear: Loneliness, $\beta = -.24$, $p = .037$), see Figure 3.15. Therefore, this result suggested that individuals with a higher level of loneliness scores tended to recognise less Social Threat words in general, regardless of the instruction given to these words.

Figure 3.14 The curvilinear regression results of loneliness on the recognition accuracy of Social Threat remember words.



Note. The N-shape bend indicate that a higher level of loneliness predicted a lower recognition accuracy of Social Threat Remember words.

Figure 3.15 The linear regression results of loneliness on the recognition accuracy of Social Threat Forget words.



Note. The slope indicate that a higher level of loneliness predicted a lower recognition accuracy of Social Threat Forget words.

C value– biased/ sensitivity. For the recognition bias data (c'), two mixed ANOVAs were undertaken with the words categories (5 levels) as independent variables, one for each instruction condition (Remember or Forget).

In the Remember condition, a significant main effect for Word Category emerged, $F(4, 292) = 11.49$, $MSE = .208$, $p < .001$, $\eta_p^2 = .136$.

Planned Contrasts for the main effect of Word Category showed that (in the Remember condition), all study participants were more likely to give a "No" answer to Physical Positive Remember words ($M = .73$, *Std. Error* = .54) than Neutral Remember words ($M = .34$, *Std. Error* = .62), $F(1, 73) = 22.84$, $MSE = .49$, $p < .001$, $\eta_p^2 = .238$; Participants were more likely to give a "Yes" answer to Physical Threat Remember words ($M = .25$, *Std. Error* = .49) than Physical Positive Remember words, $F(1, 73) = 40.59$, $MSE = .42$, $p < .001$, $\eta_p^2 = .357$, Social Threat Remember words ($M = .47$, *Std. Error* = .56), $F(1, 73) = 10.21$, $MSE = .33$, $p = .002$, $\eta_p^2 = .123$; and Social Positive Remember words ($M = .46$, *Std. Error* = .54), $F(1, 73) = 8.34$, $MSE = .38$, $p = .005$, $\eta_p^2 = .103$.

Participants were more likely to give a "No" answer to Physical Positive Remember words, $F(1, 73) = 12.72$, $MSE = .41$, $p = .001$, $\eta_p^2 = .148$; and Social Positive Remember words, $F(1, 73) = 15.68$, $MSE = .35$, $p < .001$, $\eta_p^2 = .177$. In other words, for all participants, Physical Threat Remember words were more difficult to forget whereas Physical Positive Remember words were more likely to be forgotten in the recognition task.

In the Forget condition, a significant main effect for Word Category emerged, $F(4, 292) = 8.62$, $MSE = .204$, $p < .001$, $\eta_p^2 = .106$. Planned Contrasts showed that participants were more likely to give a "No" answer to Social Positive Forget words ($M = 1.04$, *Std. Error* = .57) than Neutral Forget words ($M = .76$, *Std. Error* = .67), $F(1, 73) = 16.58$, $MSE = .35$, $p < .001$, $\eta_p^2 = .185$; Physical Threat F words ($M = .82$, *Std. Error* = .63), $F(1, 73) = 8.47$, $MSE = .40$, $p = .005$, $\eta_p^2 = .104$; Physical Positive F words ($M = .75$, *Std. Error* = .61), $F(1, 73) = 14.13$, $MSE = .45$, $p < .001$, $\eta_p^2 = .162$ and Social Threat F words ($M = .62$, *Std. Error* = .57), $F(1, 73) = 26.78$, $MSE = .49$, $p < .001$, $\eta_p^2 = .268$.

Physical Threat Forget words and Neutral Forget words were more likely to be given a No answer than Social Threat words, $F(1, 73) = 10.95$, $MSE = .29$, $p = .001$, $\eta_p^2 = .130$; $F(1, 73) = 3.62$, $MSE = .40$, $p = .061$, $\eta_p^2 = .047$.

Results of loneliness. A series of linear and curvilinear regression were undertaken to examine whether loneliness has an impact on the recognition biases, with participants' loneliness scores as the independent variable and the recognition biases in each word categories as dependent variables. The results showed no significant differences in individuals who have a higher level of loneliness in recognition bias of each categories of words, regardless of instructions, from those who scored lower in the loneliness scale.

Tagging.

The scoring of tagging. Participants were presented with the 70 words in the tagging phase of the task (for word list, see Table 3.3). They were asked to recall the instructions that followed the presented words. Correctly tagged items (an "R" answer given to a Remember word, an "F" answer given to a Forget word) were recorded as Hits. A failure to tag the instruction correctly was recorded as a Miss. The means and standard deviations of the hit rates for the tagging of each category of words were shown in Table 3.11. The proportion of words tagged correctly for the five word categories in two conditions (R and F) was computed.

The mean and standard deviation tables below show the proportion of correctly tagged items for the five word categories in the two Remember and Forget instructions.

Table 3.11. *Means and Standard Deviations of hit rates in tagging of each category of words*

Word Categories	Instructions	Mean	SD
Neutral	*Remember*	*.62*	*.23*
	Forget	*.72*	*.24*
Physical Positive	*Remember*	*.54*	*.23*
	Forget	*.75*	*.25*
Physical Threat	*Remember*	*.65*	*.24*
	Forget	*.79*	*.21*
Social Positive	*Remember*	*.58*	*.25*
	Forget	*.72*	*.21*
Social Threat	*Remember*	*.50*	*.22*
	Forget	*.76*	*.22*

Main effect. A 5 (Word Category) × 2 (Instruction) mixed analysis of variance (ANOVA) was undertaken to examine whether Word Category and Instruction have an impact on tagging performance in the directed forgetting task.

There was a significant main effect of Instruction, $F(1, 73) = 51.20$, $MSE = .102$, $p < .001$, $\eta_p^2 = .412$. Pairwise Comparisons showed that participants tagged Forget words ($M = .75$, *Std. Error* = .02) better than Remember words ($M = .58$, *Std. Error* = .02), $p < .001$, $CI_{.95} = .12, .22$. The main effect for Word Category was also significant, $F(4, 292) = 6.01$, $MSE = .029$, $p < .001$, $\eta_p^2 = .076$. Simple effects analyses showed that Physical Threat words ($M = .72$, *Std. Error* = .02) were tagged better than Physical Positive words ($M = .64$, *Std. Error* = .02), $p = .003$, $CI_{.95} = -.13, -.02$, Social Positive words ($M = .65$, *Std. Error* = .02), $p = .024$, $CI_{.95} = .01, .13$ and Social Threat words ($M = .63$, *Std. Error* = .02), $p = .001$, $CI_{.95} = .03, .15$.

There was a significant interaction between Word Category and Instruction, $F(4, 292) = 4.11$, $MSE = .043$, $p = .003$, $\eta_p^2 = .053$. Simple Effects Analyses showed that, for the effects of Word Category, participants tagged Neutral Remember words ($M = .62$, *Std. Error* = .03) better than Physical Positive Remember words ($M = .54$, *Std. Error* = .03), $p = .093$, $CI_{.95} = -.01, .17$, and Social Threat Remember words ($M = .50$, *Std. Error* = .03), $p = .004$, $CI_{.95} = .03, .21$. Participants tended to tag Physical Threat Remember words ($M = .65$, *Std. Error* = .04) better than Physical Positive Remember words, $p = .007$, $CI_{.95} = -.20, -.02$, and Social Threat Remember words, $p < .001$, $CI_{.95} = .07, .23$. Participants did not perform differently in tagging Forget words of each word category.

For the effects of Instruction, Forget words were tagged better than Remember words for Neutral words, $p = .022$, $CI._{95} = .01, .18$, Physical Positive words, $p < .001$, $CI._{95} = .13, .28$, Physical Threat words, $p < .001$, $CI._{95} = .07, .20$, Social Positive words, $p < .001$, $CI._{95} = .07, .22$ and Social Threat words, $p < .001$, $CI._{95} = .19, .33$.

Results of loneliness. Linear and curvilinear regression analyses were conducted with loneliness as independent variables and the tagging hit rate for each category of words as the dependent variables. The results showed no significant difference between individuals with a higher *vs*. lower levels of loneliness in relation to tagging hit rate.

Summary of the Results of the Directed Forgetting Task

The current study is the first study examining the impact of loneliness on the encoding and recall of emotional information. The results showed that individuals with a higher level of loneliness scores have an explicit memory bias towards Social Threat Remember words. Participants with a higher level of loneliness scores also showed a recognition bias in Neutral and emotional words.

Longitudinal Relationships between Loneliness and Cognitive Biases

Introduction

Loneliness is usually transient, based on situations, but when the experience of loneliness is prolonged, it may become chronic (Young, 1982). Situational/transient/state loneliness refers to temporary psychological distress triggered by stressful life events, for example, loss of a spouse or retirement, but usually social relationships can be restored after a short period of time. Chronic/trait loneliness, on the other hand, is a more stable state that results from the inability to restore social relationships over many years.

Chronicity of loneliness can be measured. Heinrich and Gullone (2006) summarised that the test-retest correlation of loneliness between two short time points (6 to 11 weeks) ranges between .71 and r =.85, whereas the long-term test-retest correlation of loneliness scores between two time points (between 1 to 3 years) is between .38 and .68.

Young (1982) argues that individuals who suffer from chronic loneliness tend to exhibit more interpersonal difficulties. Heinrich and Gullone (2006) also conclude that compared with trait loneliness participants, chronically lonely individuals may be more likely to suffer from long-term interpersonal deficits. For example, Spitzberg and Hurt (1987) propose that the longer one stays lonely, the more self-blaming one will become. They also suggest chronically lonely individuals show less social skills. Hojat (1983) argues that chronic lonely individuals tend to have lower self-esteem, they are less extraverted, more likely to be depressed, anxious and neurotic and tend to have more external locus of control than transient lonely individuals. Furthermore, Gerson and Perlman (1979) argue that transient lonely individuals tend to exhibit better communications of emotional messages when compared with chronic lonely individuals.

Chronic loneliness also tends to be associated with specific cognitive processes, such as attributional style (Vanhalst, et al., 2015), difficulties in concentration (Jaremka, et al., 2014) and memory function as the measurement of IQ (Ayalon et al., 2016). Qualter et al. (2015) summarise findings from a series of cross-sectional studies and argue that loneliness is associated with cognitive biases that

promote negative thinking. Reciprocally, their findings support the notion that these negative thoughts promote prolonged loneliness.

Although the findings of the longitudinal cognitive studies above support the association between chronic loneliness and cognitive bias, studies investigating cognitive bias in lonely individuals longitudinally are still largely missing from the literature. Therefore, the effect of chronic loneliness on cognitive bias, and whether cognitive bias contributes to the development and maintenance of loneliness is still unclear.

One of the few studies that examines the effect of longitudinal loneliness on individual's attributions and emotions in response to social inclusion and social exclusion was carried out by Vanhalst et al. (2015). They conducted a longitudinal study to examine the attributional style in lonely adolescents using vignettes depicting social inclusion and exclusion scenarios. They found that chronically lonely adolescents were hypersensitive to social exclusion and hyposensitive to social inclusion. Moreover, chronically lonely adolescents were also more likely to attribute social inclusion to external factors and attribute social exclusion to internal factors. Shaver et al. (1985) found similar results revealing that trait lonely individuals tend to make internal and stable attributions, and prefer passive coping styles. However, state lonely individuals tend to attribute loneliness to both internal and external attributions, and prefer to adopt active coping strategies.

Wols, Scholte, and Qualter (2015) examined chronic loneliness and emotional functional skills using the cross-lagged path model, which is a model constructed in the structural equational modelling examining not only the impact of the level of loneliness on the emotional functional skills across time, but also the impact of emotional functional skills on loneliness across time. They found that poorer emotional functional skills predicted increases in loneliness but also that loneliness, in turn, predicted the reduction in emotional functional skills in both males and females. This finding supports Cacioppo and Hawkley's (2009) regulatory loop which postulates loneliness impairs the capacity to regulate emotions, and hence results in vigilance to social threat cues in a social environment. Moreover, this finding also demonstrates that loneliness has deleterious effects transitionally

and longitudinally, thereby supporting the idea that cognitive bias might be involved in the development and maintenance of loneliness.

Although studies such as those mentioned in the foregoing investigate the bidirectional relationship between loneliness and cognitive process, it is still an area which has not been widely researched. Therefore, this study will examine cognitive bias, including attention and memory bias systematically at two time points in lonely individuals. Furthermore, the study will examine whether loneliness impacts on attention and memory of emotional information longitudinally and vice versa.

Method

Participants

Participants were recruited by on-campus flyers and emails. Interested participants completed the questionnaires and cognitive tasks in exchange for study credits and a £5 Amazon voucher. In the data collection of Time Point 1 (Time 1), 77 university students completed the study. At the second Time Point (Time 2) of data collection 10 months later, all participants who finished the cognitive studies at Time 1 were invited to complete a follow up study. A subset of twenty three people (four males and nineteen females) returned to complete the cognitive tasks and questionnaires at Time 2. All were native English speakers and reported normal or corrected-to-normal vision and normal hearing. The age range was from 19 to 49, *(M* = 24.22, *SD* = 7.67). Each participant was rewarded with a £5 Amazon voucher and 6 course credits.

Measures

The same questionnaires that were used at Time 1 were distributed to participants at the second time point. Therefore, participants completed four measures: the Revised UCLA Loneliness Scale (Russell et al., 1980), the Centre for Epidemiologic Studies Depression Scale (CES-D, Radloff, 1977), the Brief Fear of Negative Evaluation scale (Leary, 1983) and the Interaction Anxiousness scale (Leary, 1983). The Mean and Standard Deviation tables of each of the scales at Time 1 and Time 2 are shown in Table 3.12.

Table 3.12. *Means and Standard Deviations of the score of Loneliness, Depressive Symptoms, Fear of Negative Evaluations and Interaction Anxiousness at Time 1 and Time 2.*

	Mean Time 1 (*N*=74)	SD Time 1	Mean Time 2 (*N*=23)	SD Time 2
Loneliness	39.89	9.95	38.43	10.30
Depressive symptoms	16.62	9.94	15.83	12.44
Fear of Negative Evaluation	37.89	12.28	40.70	11.14
Interaction Anxiousness	44.66	11.38	43.39	10.28

Cognitive Task Procedure

The tasks used in the second stage of the study were the same as the first stage. Participants were invited to a laboratory room to complete the Serial Recall task, Directed Forgetting task and the Emotional Stroop task. The order of the three tasks completed by participants was counterbalanced. The experiment was executed using *E-Prime 2.0* software (Schneider, Eschman, & Zuccolotto, 2002) on a desktop computer or a laptop.

Analysis Technique

Time 2 cognitive task data. For the cognitive task data, the analysis technique for Time 2 was the same as for Time 1. Three mixed ANOVAs were performed to analyse the impact of valence of words and loneliness on the performance of cognitive tasks, one for each task. Within group variables were the factors that were controlled for the cognitive tasks, e.g. sound conditions, serial positions, word categories, instructions. Post hoc tests were conducted for significant main effects to investigate the differences between each level of the factor. All Post Hoc tests used Bonferroni correction for significance levels. This is because when testing multiple pairs of variables based on one data set, it is likely to increase the probability of making a type 1 error (Napierala, 2012). Bonferroni correction therefore reduces the probability of inflation of alpha level.

To test whether loneliness has an impact on the performance of cognitive tasks, linear and curvilinear regression analyses were undertaken with loneliness as the independent variable.

Results

Serial Recall Task

Scoring of serial recall. Scoring of the Serial Recall task was the same as at Time 1. The proportion of correct responses for each serial position was calculated for each sound condition.

ANOVA results. A 6 × 8 (Sound Condition x Serial Position) repeated measure ANOVA with Sound Condition and Serial Position as independent variables showed significant main effects of Sound Condition, $F(5, 110) = 18.17$, $MSE = .063$, $p < .001$, $\eta_p^2 = .452$, and Serial Positions, $F(7, 154) = 32.86$, $MSE = .258$, $p < .001$, $\eta_p^2 = .613$. The interaction between Sound Condition and Serial Positions was also significant, $F(35, 770) = 1.45$, $MSE = .011$, $p = .044$, $\eta_p^2 = .062$.

Orthogonal contrasts on sound conditions were undertaken to test more specific hypotheses about the action of the different sound conditions on serial recall performance. The orthogonal contrast showed that the difference between the silent condition and all other conditions combined was significant, $F(1, 22) = 38.57$, $MSE = .012$, $p < .001$, $\eta_p^2 = .637$. This confirmed that the typical irrelevant speech effect had been replicated.

Thereafter, orthogonal contrasts between sound conditions showed that Social Positive ($M = .59$, *Std. Error* = .17) and Physical Threat words ($M = .58$, *Std. Error* = .18) did not differ from Neutral words ($M = .61$, *Std. Error* = .17) in their effect on serial recall, $F(1, 22) = .79$, $MSE = .005$, $p = .384$, $\eta_p^2 = .035$; $F(1, 22) = 1.25$, $MSE = .013$, $p = .276$, $\eta_p^2 = .054$. However, Social Threat stimuli ($M = .55$, *Std. Error* = .16) and Physical Positive Stimuli ($M = .58$, *Std. Error* = .15) caused more disruption to serial recall performance than Neutral stimuli, $F(1, 22) = 16.92$, $MSE = .005$, $p < .001$, $\eta_p^2 = .435$; $F(1, 22) = 3.43$, $MSE = .005$, $p = .077$, $\eta_p^2 = .135$.

Social Positive words did not differ from Physical Threat words in their effect on serial recall, $F(1, 22) = .71$, $MSE = .006$, $p = .408$, $\eta_p^2 = .031$. However, Social Threat words caused more disruption than Social Positive words and Physical Positive words on serial recall performance, $F(1, 22) = 8.24$, $MSE = .006$, $p = .009$, $\eta_p^2 = .273$, $F(1, 22) = 6.06$, $MSE = .004$, $p = .022$, $\eta_p^2 = .216$. There was no difference between the effects of Social Positive words and Physical Threat words, $F(1, 22) = .71$, $MSE = .006$, $p = .408$, $\eta_p^2 = .031$, Physical Positive and Physical Threat words,

$F(1, 22) = .007$, $MSE = .010$, $p = .935$, $\eta_p^2 = .000$, and Social Threat and Physical Threat words, $F(1, 22) = 2.26$, $MSE = .011$, $p = .147$, $\eta_p^2 = .093$, on serial recall performance.

Results of loneliness. A series of linear and curvilinear regression were undertaken to examine whether loneliness has an impact on the recall of digits against a background of irrelevant sound. The results were shown in table 3.13. The results showed that loneliness is a significant positive predictor for the items recalled when there were no background sound, Silent (linear: $\beta = .46$, $p = .029$*) or when agasint the background sounds of Physical Threat words (linear: $\beta = .44$, $p = .034$*). Moreover, the curvilinear trends of loneliness on the recall of digits in the background conditions of Neutral (Loneliness^2: β=3.07, p=.072, one-tailed), Social Threat (Loneliness^2: β=2.95, p=.080, one-tailed) and Physical Positive (Loneliness^2: β=3.39, p=.044*, Loneliness: β=-3.08, p=.064, one-tailed) words were approaching significance.

The results indicate that lonely individuals showed better serial recall performance in the Silent condition and the Physical Threat condition thereby indicating better attentional control when processing of irrelevant Physical Threat information.

Irrelevant sounds containing emotional meanings impaired serial recall performance in healthy individuals (Buchner, 2004, 2006), however, for lonely individuals, this effect was reversed. Only one previous study has investigated auditory processing in lonely adults, and this study found that lonely individuals tend to have difficulties in attentional control (Cacioppo et al., 2000). In Cacioppo et al.'s (2000) study, to-be-remembered and to-be-ignored items are both consonant vowel pairs, whereas, in the Serial Recall task in the current study, the to-be-remembered items were digits and the to-be-ignored items were sounds. Taken together, the better serial recall performance of lonely, compared to non-lonely, lonely individuals may be related to a better ability in ignoring information that conflicts across different sensory channels. However, when the input of sensory information is in the same modality, such as in the emotional Stroop task, whereby both attended and to-be-ignored dimensions are visual, or the Dichotic listening task, whereby both attended and to-be-ignored information is auditory, lonely individuals showed an impaired

performances. The results suggest that the interfering information impairs cognitive performance when it is in the same modality as the target material.

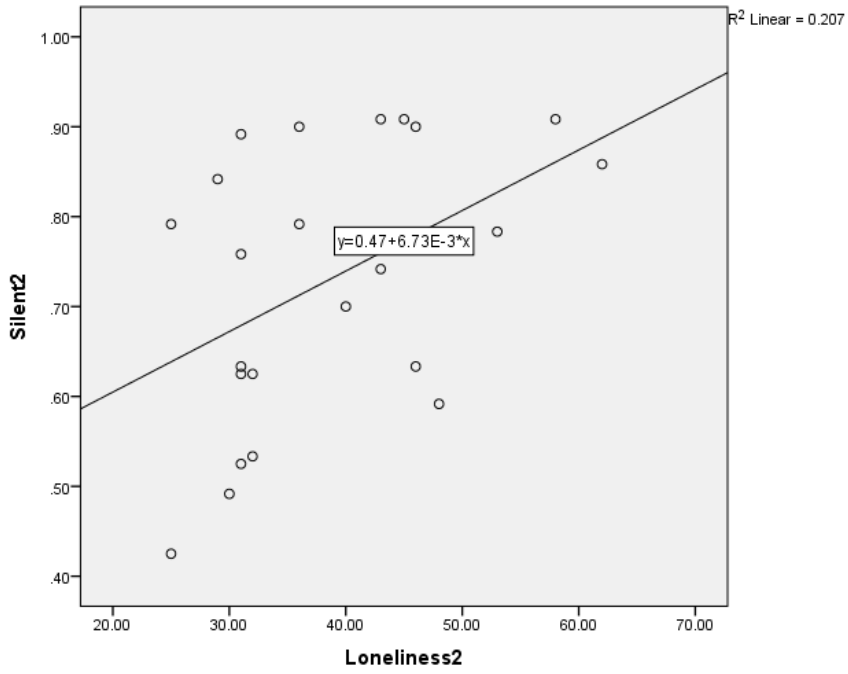
Table 3.13. *The regression results with loneliness as independent variable, the proportion of correct response for the silent and irrelevant sound conditions*

	Silent			Neutral			Physical Threat			Physical Positive			Social Threat			Social Positive		
	B	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*
Linear Regression																		
Loneliness	**.01**	**.003**	**.46***	.01	.003	.30	**.01**	**.003**	**.44***	.01	.003	.33	.01	.003	.35	.01	.004	.30
Curvilinear Regression																		
Loneliness	.02	.02	1.17	.05	.03	3.07	.04	.03	2.10	.05	.03	3.39	.04	.02	2.95	.05	.03	2.89
Loneliness^2	.000	.000	-.72	-.001	.000	-2.79	.000	.000	-1.67	**-.001**	**.000**	**-3.08***	.000	.000	-2.62	-.001	.000	-2.61

$N = 21$, $^*p < .05$

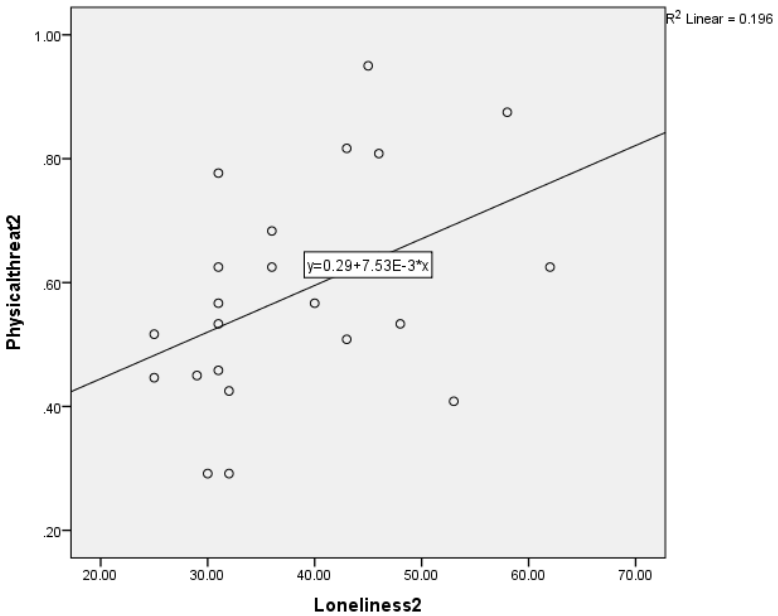
Note. A higher level of loneliness is associated with a better Serial Recall performance in the Silent and Physical Threat condition, suggesting lonely individuals are less likely to distract by the background sounds in these conditions.

Figure 3.16 The linear regression graph for the effect of loneliness on the Serial Recall performance for silent condition at Time 2



Note. Loneliness participants correctly recalled the serials of the digits when there were no sounds presented in the background.

Figure 3.17 The linear regression graph for the effect of loneliness on the Serial Recall performance for Physical Threat condition at Time 2



Note. Lonely individuals recalled more digits in the correct order when the background speech were Physical Threat words.

Emotional Stroop task.

Reaction time data. The mean reaction time (in milliseconds) taken for participants to name the colour of words was computed individually for each category of word, the results were shown in table 3.14. Fifteen incorrect trials (accounted for 0.004% of the whole sample) and 115 outliers (accounted for 2.7% for the whole sample) were removed from the analyses.

Table 3.14. *Means and Std. Deviations of reaction time (in milliseconds)of each of the word categories*

Word Category	Mean of Reaction Time	Standard Deviation
Neutral	614.01	121.09
Physical Positive	597.92	109.64
Physical Threat	607.20	110.07
Social Positive	599.12	107.55
Social Threat	603.14	107.91

AVOVA results. A repeated measure analysis of variance (ANOVA) of the reaction time taken to name the colour of each word in each category was carried out to examine effects of Word content (a within-subject variable with 5 levels) on reaction time.

The results showed a significant main effect of Word Category, $F(4, 76) = 3.04$, $MSE = 282.14$, $p = .022$, $\eta_p^2 = .138$. Orthogonal contrasts analysis showed that Neutral words were named slower than Physical Positive words, $F(1, 19) = 8.82$, $MSE = 587.18$, $p = .008$, $\eta_p^2 = .317$, and Social Positive words, $F(1, 19) = 568.13$, $MSE = 51809.13$, $p < .001$, $\eta_p^2 = .968$. The latency of naming the colour of Neutral words did not differ from the latency of naming the colour of Physical Threat words, $F(1, 19) = 1.28$, $MSE = 722.70$, $p = .271$, $\eta_p^2 = .063$ and Social Threat words, $F(1, 19) = 2.14$, $MSE = 806.77$, $p = .160$, $\eta_p^2 = .101$.

There were no differences between the latency of naming the colour of the other categories of words. Moreover, there were no differences in the reaction times of colour naming between Physical Positive and Physical Threat words, $F(1, 19) = 2.14$, $MSE = 806.77$, $p = .160$, $\eta_p^2 = .101$; Physical Positive and Social Positive words, $F(1, 19) = .060$, $MSE = 482.34$, $p = .809$, $\eta_p^2 = .003$; Physical Positive and

Social Threat words, $F(1, 19) = 1.27$, $MSE = 427.17$, $p = .273$, $\eta_p^2 = .063$; Physical Threat and Social Positive, $F(1, 19) = 2.47$, $MSE = 527.80$, $p = .132$, $\eta_p^2 = .115$; Physical Threat and Social Threat words, $F(1, 19) = .57$, $MSE = 584.81$, $p = .461$, $\eta_p^2 = .029$, and Social Positive and Social Threat words, $F(1, 19) = 1.31$, $MSE = 246.35$, $p = .267$, $\eta_p^2 = .064$.

Results of loneliness. A series of linear and curvilinear regression analyses were run, with loneliness as the predictor variable and the reaction time for naming each category of words (Neutral, Social Positive, Social Threat, Physical Positive, Physical Threat) as outcome variables. The results showed no significant effects of loneliness on the colour naming latency for different categories of words, see Table 3.15. Linear and curvilinear regressions were undertaken to examine whether loneliness has an impact on the errors made in the colour naming of each category of words. No significant effects were found between these factors, see Table 3.16.

Table 3.15. *The results of linear and curvilinear regression, with loneliness as independent variable, reaction time for naming each category of words in the Emotional Stroop task as dependent variables*

	Neutral			Physical Threat			Physical Positive			Social Threat			Social Positive		
	B	*SE B*	*B*	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*
							Linear Regression								
Loneliness	1.57	2.82	.13	1.80	2.55	.17	.49	2.57	.05	1.05	2.49	.10	.76	2.50	.07
							Curvilinear Regression								
Loneliness	-.77	27.21	-.66	-10.27	24.46	-.97	-9.09	24.82	-.86	-13.69	23.86	-1.33	-15.98	23.82	-1.55
Loneliness^2	.11	.31	.80	.14	.28	1.14	.11	.28	.91	.17	.27	1.44	.19	.27	1.63

Note. $N = 21$, $*p < .05$. Loneliness participants were not differed from non-lonely participants in the reaction time of naming the colour of Neutral, Physical Threat, Physical Positive, Social Threat and Social Positive words in the emotional Stroop task at Time 2.

Table 3.16. *The results of linear and curvilinear regression, with loneliness as independent variable, errors made in naming each category of words in the Emotional Stroop task as dependent variables at Time 2*

	Neutral			Physical Threat			Physical Positive			Social Threat			Social Positive		
	B	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*
							Linear Regression								
Loneliness	.004	.01	.09	-.001	.01	-.04	.000	.01	-.002	.01	.01	.25	.01	.01	.15
							Curvilinear Regression								
Loneliness	.08	.10	1.87	.08	.08	2.26	.13	.09	3.06	.12	.07	3.71	.12	.10	2.69
Loneliness^2	-.001	.001	-1.79	-.001	.001	-2.31	-.001	.001	-3.08	-.001	.001	-3.48	-.001	.001	-2.55

Note. $N = 21$, $*p < .05$. Loneliness participants were not differed from non-lonely participants in the error made in naming the colour of Neutral, Physical Threat, Physical Positive, Social Threat and Social Positive words in the emotional Stroop task at Time 2.

Directed Forgetting Task

Recall.

Proportion of words recalled for each word category. The proportion of words remembered for the five word categories (Neutral, Social Threat, Social Positive, Physical Threat, and Physical Positive) in the two instruction conditions (Remember and Forget) was computed. A 5 (Word Category) × 2 (Instruction) mixed analysis of variance (ANOVA) was carried out to examine whether Word Category and Instruction have an impact on recall performance in the directed forgetting task.

This analysis revealed a significant main effect of Word Category, $F(4, 88) = 3.66$, $MSE = .025$, $p = .008$, $\eta_p^2 = .143$. Pairwise Comparisons revealed that Neutral words were recalled better than Physical Positive words, $p = .089$, $CI._{95} = -.007, .169$, Physical Threat words were recalled better than Physical Positive words, $p = .012$, $CI._{95} = .014, .160$. There were no recall differences between other categories of words.

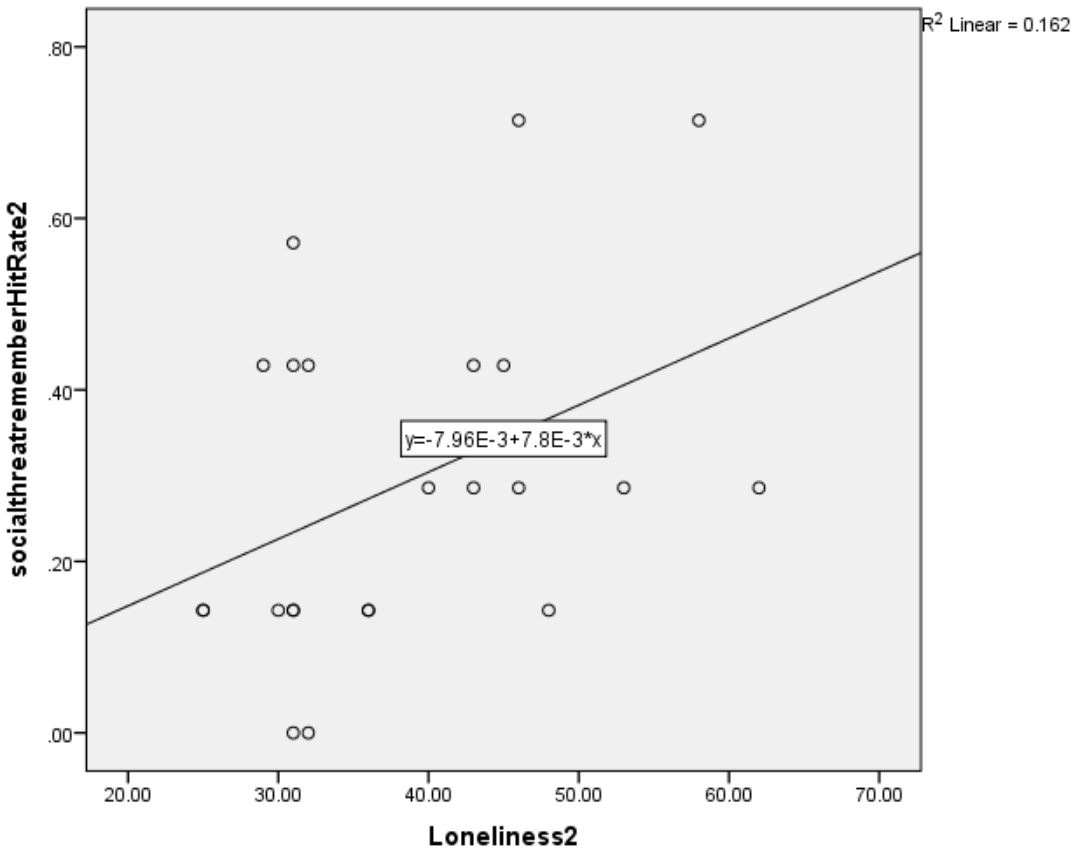
The analysis showed a significant main effect of Instructions, $F(1, 22) = 110.07$, $MSE = .045$, $p < .001$, $\eta_p^2 = .833$, thereby demonstrating a typical directed forgetting effect: participants recalled more words followed by the Remember instruction than the Forget instruction.

Moreover, there was a significant interaction between Word Category and Instruction, $F(4, 88) = 4.09$, $MSE = .018$, $p = .004$, $\eta_p^2 = .157$. Simple effect analyses (Bonferroni correction) showed that the interaction was driven by the finding that recall performance of remember words was better than forget words in all five word categories: Neutral ($p < .001$, $CI._{95} = .174, .336$), Physical Threat ($p < .001$, $CI._{95} = .330, .527$), Physical Positive ($p < .001$, $CI._{95} = .138, .347$), Social Threat ($p < .001$, $CI._{95} = .131, .341$), Social Positive ($p < .001$, $CI._{95} = .224, .372$). The recall of Physical Threat Remember words was better than the recall of Physical Positive Remember words, $p = .019$, $CI._{95} = .021, .339$. The recall of Neutral Forget words was better than the recall of Physical Threat Forget words, $p = .040$, $CI._{95} = .002, .159$.

Results of loneliness. A series of linear and curvilinear regression were undertaken with loneliness as the independent variable, and the proportion of correct recall of words in the five word categories (Neutral, Social Threat, Social Positive, Physical Threat, and Physical Positive) in the remember and forget conditions as dependent variables. The results showed that loneliness is a significant predictor for the

recall of Social Threat Remember words at Time 2, (Linear: β= .40, p= .057*, one-tailed). The results indicated that individuals with a higher level of loneliness recalled more Social Threat Remember words at Time 2 in the Directed Forgetting task, see Figure 3.18, suggesting a heightened memory bias for socially threatening information. The results also echoed the results in at Time 1, that high lonely individuals tend to have heightened memory for Social Threat Remember words. The results are promising as they were replicated in two time points. There were no significant effects of loneliness on the recall of other categories of words (Neutral, Social Positive, Physical Threat, and Physical Positive words) in either Remember or Forget instructions.

Figure 3.18 The linear regression graph of loneliness on the recall of Social Threat Remember words at Time 2



Note. A higher level of loneliness is associated with a better recall of Social Threat Remember words at Time 2, which is in consistent with the results at Time 1, suggesting loneliness is associated with a memory biases of Social Threat information.

Recognition.

Scoring of recognition. In the recognition task, participants were presented with foil words that were similar to the learned information. The participants were required to make decisions of whether a given word had been presented during study, or not. "Hit" and "Miss" refers to the correct and incorrect answers for words presented for recall. "False Alarm" and "Correct Rejection" refers to the correct and incorrect response of lure words. A total number of Hits, Misses, False Alarms and Correct Rejections was recorded and used for analysis.

d' prime and c' value. d' prime—which measures the broad sensitivity of detecting a signal—and c response bias were calculated using the Hit and False Alarm rates for words in each of the categories followed by the remember or forget instructions.

A greater score of d' suggests a better performance (e.g., greater sensitivity) in recognition. Negative c indicates a bias towards a "Yes" response and positive c indicates a bias towards a "No" response.

Main effect of d' prime. For recognition sensitivity data (d' prime), two mixed ANOVAs were carried out on d' prime data, one for each condition (Remember and Forget). For Remember conditions, there was no significant effect of Word Category, $F(4, 80) = .55$, $MSE = 1.68$, $p = .699$, $\eta p^2 = .027$. In the Forget condition, the main effect was also not significant for Word Category, $F(4, 80) = .66$, $MSE = 1.80$, $p = .619$, $\eta p^2 = .032$.

Results of loneliness. Linear and curvilinear regression analyses were undertaken with the loneliness score as the independent variable and the d' prime score for each word category in Remember and Forget instruction respectively, as dependent variables. The results were presented in Table 3.17 and Table 3.18 respectively for Remember and Forget words. The results showed that individuals with a higher level of loneliness scores recognise less Neutral Remember words (curvilinear: Loneliness $\beta = 3.82$, $p = .039$*, Loneliness^2 $\beta = -3.73$, $p = .043$*), Physical Threat Remember words (curvilinear: Loneliness $\beta = 3.74$, $p = .036$*, Loneliness^2 $\beta = -3.46$, $p = .051$*, one-tailed) and Physical Positive Remember words (curvilinear: Loneliness $\beta = 3.97$, $p = .031$*, Loneliness^2 $\beta = -3.90$, $p = .034$*), see Figure 3.19.

For Forget words, the results showed that loneliness was a significant predictor for the Physical Threat Forget words (curvilinear: Loneliness β = 3.71, p = .043*, Loneliness^2 β = -3.50, p = .054*, one-tailed), see Figure 3.19.

Table 3.17. *The results of linear and curvilinear regression analyses, with loneliness as independent variable, recognition accuracy of each category of word followed by the Remember instruction in the Directed Forgetting task as dependent variables are Time 2*

	Neutral Remember d'			Physical Threat Remember d'			Physical Positive Remember d'			Social Threat Remember d'			Social Positive Remember d'		
	B	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*
							linear Regression								
Loneliness	*.01*	*.03*	*.12*	*.03*	*.02*	*.32*	*.01*	*.03*	*.10*	*.001*	*.02*	*.01*	*.02*	*.03*	*.20*
							curvilinear Regression								
Loneliness	***.41***	***.18***	***3.82****	***.38***	***.17***	***3.74****	***.47***	***.20***	***3.97****	*.20*	*.19*	*1.97*	*.17*	*.21*	*1.54*
Loneliness^2	***-.01***	***.002***	***-3.73****	***-.004***	***.002***	***-3.46****	***-.01***	***.002***	***-3.90****	*-.002*	*.002*	*-1.98*	*-.002*	*.002*	*-1.35*

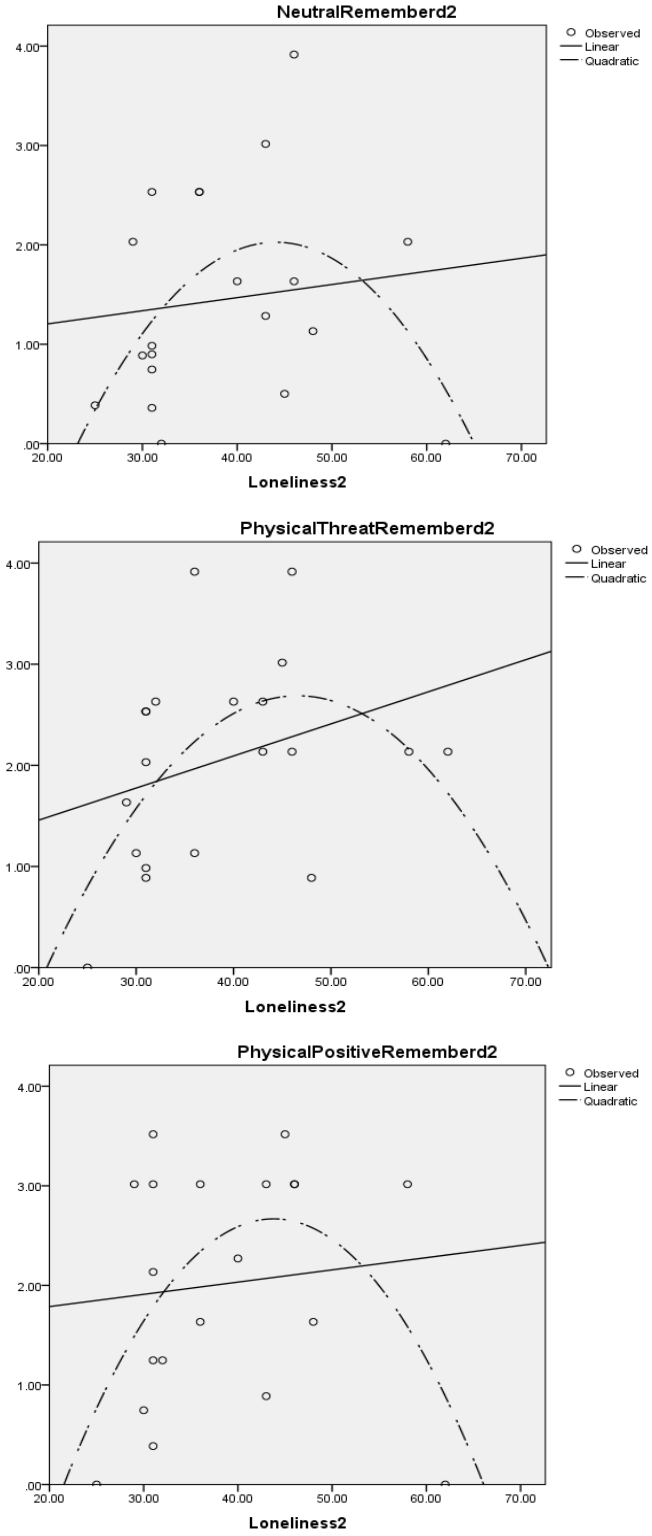
Notes. $N = 21$, $p < .05$*

Table 3.18. *The results of linear and curvilinear regression analyses, with loneliness as independent variable, recognition accuracy of each category of word followed by the Forget instruction in the Directed Forgetting task as dependent variables at Time 2.*

	Neutral Forget d'			Physical Threat Forget d'			Physical Positive Forget d'			Social Threat Forget d'			Social Positive Forget d'		
	B	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*
							Linear Regression								
Loneliness	*.05*	*.03*	*.30*	*.03*	*.03*	*.24*	*.02*	*.02*	*.23*	*.01*	*.02*	*.21*	*.003*	*.02*	*.03*
							Curvilinear Regression								
Loneliness	*-.03*	*.28*	*-.17*	***.41***	***.19***	***3.71****	*.10*	*.19*	*.97*	*-.06*	*.12*	*-.87*	*.17*	*.19*	*1.66*
Loneliness^2	*.001*	*.003*	*.47*	***-.004***	***.002***	***-3.50****	*-.001*	*.002*	*-.75*	*.001*	*.001*	*1.08*	*-.002*	*.002*	*-1.65*

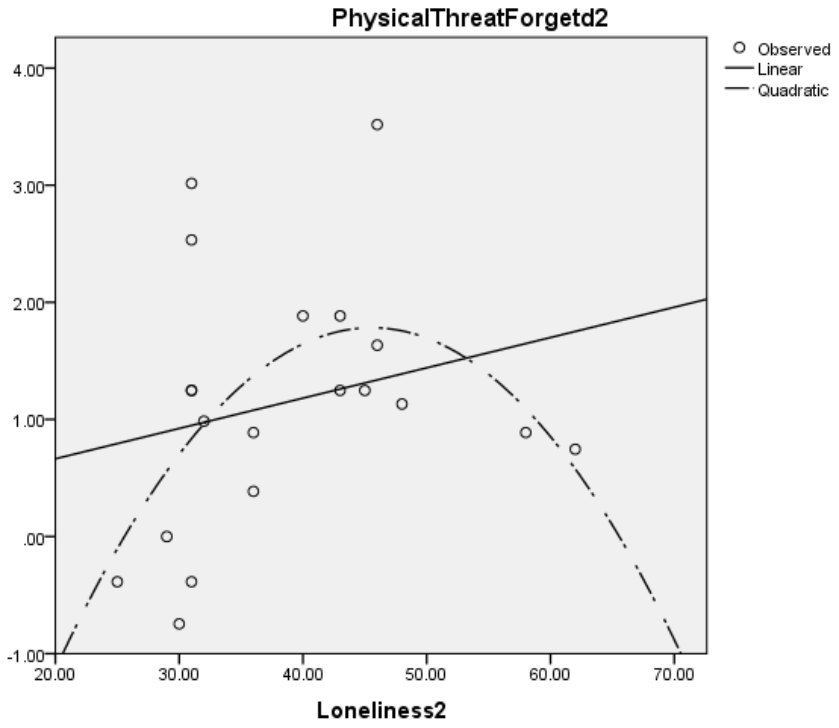
Notes. $N = 21$, $^*p < .05$

Figure 3.19 The curvilinear regression between the effect of loneliness on the recognition accuracy of Neutral Remember, Physical Threat Remember and Physical Positive Remember words.



Note. Loneliness is related to a poorer recognition accuracy of Neutral Remember, Physical Threat Remember and Physical Positive Remember words at Time 2.

Figure 3.20 Curvilinear regression graph of loneliness on the recognition accuracy of Physical Threat Forget words at Time 2



Note. Loneliness is associated with a poorer recognition accuracy of the Physical Threat Forget words at Time 2.

c value– biased/ sensitivity. For the recognition bias data (c), two mixed ANOVAs were undertaken, one for each instruction condition (Remember or Forget).

In the Remember condition, there was a significant main effect for Word Category, $F(4, 80) = 3.06$, $MSE = .367$, $p = .021$, $\eta_p^2 = .133$. Pairwise Comparisons showed that the Neutral Remember words are more likely to be given a "Yes" answer compared with Physical Positive Remember words, $p = .045$, $CI._{95} = .009, 1.27$.

In the Forget condition, there was a significant main effect for Word Category, $F(4, 80) = 2.21$, $MSE = .338$, $p = .076$, $\eta_p^2 = .099$. Pairwise Comparisons showed no significant differences between the recognition biases of each word categories.

Results of loneliness. Linear and curvilinear regression analyses were run with loneliness as the independent variable and the recognition bias of each word category in the Remember and Forget instruction respectively as dependent variables. The results showed no significant differences between recognition biases of each categories of words in Remember and Forget instructions.

Tagging

The scoring of tagging. Participants were presented with the 70 words in the tagging phase of the task. They were asked to recall the instructions that followed the presented words. Correctly tagged items (an "R" answer given to a Remember word, an "F" answer given to a Forget word) were recorded as Hits. A failure to tag the instruction correctly was recorded as a Miss. The proportion of words tagged correctly for the five word categories in two conditions (R and F) was computed.

Main effect. A 5 (Word Category) × 2 (Instruction) mixed analysis of variance (ANOVA) was undertaken to examine whether Word Category and Instruction have an impact on the tagging accuracy in the Directed Forgetting task.

There was no significant main effect of Instruction, $F(1, 20) = 1.26$, $MSE = .164$, $p = .276$, $\eta_p^2 = .059$. That is, there were no differences in participants' tagging of the Remember and Forget words.

There was a significant main effect of Word Category, $F(4, 80) = 3.52$, $MSE = .048$, $p = .019$, $\eta_p^2 = .164$. Pairwise Comparisons showed that Physical Threat words were Tagged better than Social Threat words, $p = .074$, $CI._{95} = -.006, .217$ one-tailed.

There was a significant interaction between Word Category and Instruction, $F(4, 80) = 2.37$, $MSE = .041$, $p = .059$, $\eta_p^2 = .106$, one-tailed. Pairwise comparisons showed that in Remember condition, Neutral Remember words were tagged better than Social Threat Remember words, $p = .054$, $CI._{95} = -.002, .383$, Physical Threat Remember words were tagged better than Physical Positive Remember words, $p = .074$, $CI._{95} = -.011, .378$, Physical Threat Remember words were tagger better than Social Threat Remember words, $p = .002$, $CI._{95} = .063, .359$.

Results of loneliness. Linear and curvilinear regression analyses were run, with loneliness score as the predictor variable and the tagging of each word category in Remember and Forget condition as the dependent variables. The results showed no significant impact of loneliness on the tagging accuracy of each category of words, irrespective of instructions.

Analysis Plan of Longitudinal Data

Correlation between measures. The correlation between loneliness at two time points was .67 (n = 23). This is in line with the finding of the correlation of loneliness outlined by Heinrich and Gullone (2006). They concluded that the correlation of loneliness between 6 to 11 weeks is ranges between .71 and .85, whereas the correlation of loneliness between 1 to 3 years is between .38 and .68. The lapse of the two time points in the current study was 10 months. Therefore, the correlation of loneliness level at the two time points were in line with the figures reported by Heinrich and Gullone (2006).

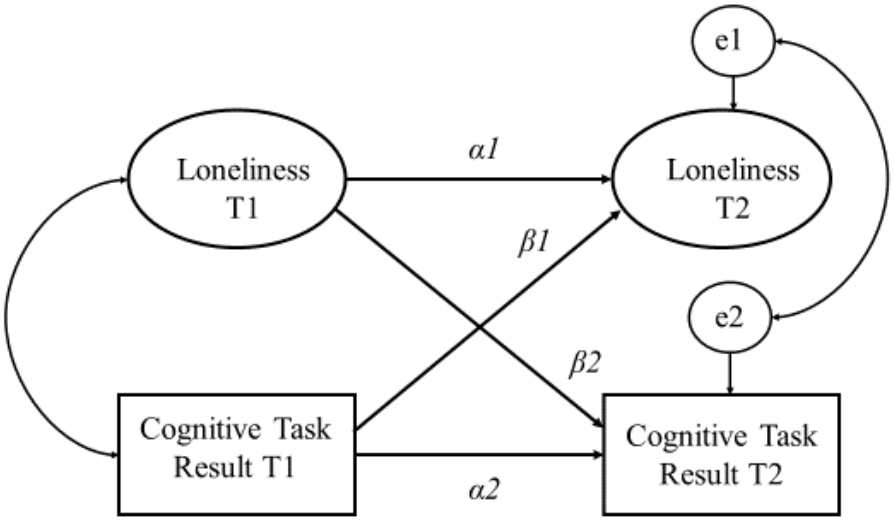
Cross lagged panel model. A mixed ANOVA was used to examine the impact of loneliness and word category on the performance of each cognitive task at Time 1. At Time 2, a mixed ANOVA was used to examine the same effects. The linkage between the two time points was examined by the cross lagged panel model. By using this analysis, the variables could be compared not only within each time point but also across the two time points. Moreover, the analysis of the current study will fill the gap in the literature by examining not only the role of loneliness on cognitive bias but also the role of cognitive bias on loneliness.

This study utilised a two-wave, two-variable cross lagged modelling design, also called panel model, to examine the relations of different constructs in two time points, see Figure 3.21.

Figure 3.21 below shows that Loneliness Level and Cognitive Tasks Performances are two different constructs measured at two time points, the linear regression coefficients $\alpha 1$ (Loneliness T1 → Loneliness T2) and $\alpha 2$ (Cognitive Task Results T1 → Cognitive Task Results T2) describe the autoregressive effects, or the effect of Loneliness on itself measured at a later time. The autoregressive effects describe the stability of the constructs from one occasion to the next (Selig & Little, 2012). In this study, this refers to the stability of loneliness across 10 month time.

The regression coefficients $\beta 1$ (Loneliness T1 → Cognitive Task Results T2) and $\beta 2$ (Cognitive Task Results T1 → Loneliness T2) represent the cross-lagged effects, or the effect of Cognitive Tasks Performances on Loneliness at a later occasion. A significant coefficient of $\beta 1$ represent Cognitive Tasks Performances are related to Loneliness level at Time 2.

Figure 3.21 Cross-lagged model for loneliness level and cognitive task performance in this study



The standardised estimation of regression weights was used to report the relationships between variables. The independent variables are loneliness level at time one and performance of each tasks at time one. The dependent variables are loneliness level at time two and performance of each task at time two. The cross-lagged panel model was used to analyse if loneliness and cognitive task performance at Time 1 have an impact on participants' loneliness level and cognitive task performance after 10 months.

The Cross Lagged analysis was conducted in IBM SPSS AMOS 22, the model used to analyse the data for current study is shown below.

Adjustment of alpha level. Bonferroni correction for alpha level was not applied in the current study. This is because the study is exploratory in nature and therefore any reduced alpha level may eliminate possibly significant effects.

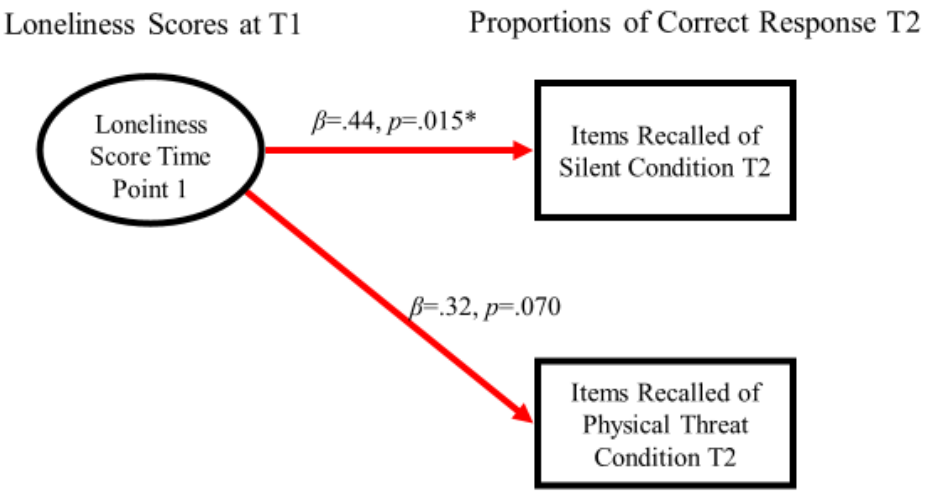
Serial Recall Task

Scoring of the serial recall task. The proportion of correct responses for each sound condition: Silent, Neutral, Social Positive, Physical Positive, Social Threat, Physical Threat was calculated at Time 1 and Time 2. These were then used in the cross-lagged analysis.

Loneliness results. The table below shows the results for the two-wave, two-variable path model of this study. Autoregressive effects refer to the effect of a construct on itself measured at a later time (Selig & Little, 2012). The autoregressive effects (Loneliness Level Time 1 → Loneliness Level Time 2, Serial Recall Performance Time 1→ Serial Recall Performance Time 2) were carried out on the loneliness scores and the serial recall performance from Time 1 to Time 2. All autoregressive effects of loneliness were statistically significant ($p < .001$), the stability coefficients for loneliness show that individual differences in loneliness is relatively stable over the 10 month lag between measurements.

The cross-lagged effects (Loneliness Time 1 → Serial Recall Performance Time 2, Serial Recall Performance Time 1 → Loneliness level Time 2) were used to investigate the effect of a construct on another measure at a later point in time. The cross-lagged effects of participants' loneliness level at Time 1 on the proportion of correct responses for all sound conditions showed that a higher level of loneliness at Time 1 predicts a better recall of digits of the Silent ($\beta = .44$, $p = .015$*) and Physical Threat condition ($\beta = .32$, $p = .070$), suggested that a higher level of loneliness is associated with a better focal-task engagement overtime, see Figure 3.22. Although previous research outlined that negative valence auditory distractor impaired serial recall more than neutral and irrelevant distractors (Buchner et al., 2006), the current findings suggest that loneliness may influence individual's cognition over time, and facilitate an enhanced focal task engagement acting to shield against attentional diversion produced by the distractors.

Figure 3.22 The cross-lagged effect of Loneliness effects and Serial Recall and with regression parameters



Note. Red line indicates a positive effect, blue line indicates a negative effect. A higher level of loneliness at Time 1 is associated with a better Serial Recall of Silent and Physical Threat condition at Time 2.

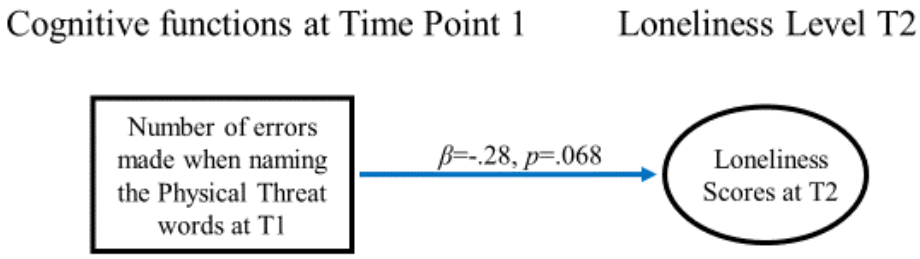
Emotional Stroop

Scoring of Emotional Stroop task. The reaction time for naming each category of words: Neutral, Social Threat, Social Positive, Physical Threat and Physical Positive at Time 1 and Time 2 was subjected to the cross-lagged analyses.

Results of the cross-lagged path model of the Emotional Stroop task. There was no cross-lagged effect of loneliness level at Time 1 on the Reaction Time of naming the colour of each category of words at Time 2. The cross-lagged effect of Reaction Time of naming each category of words at Time 1 on Loneliness level at Time 2 was not significant. The results indicated that loneliness level had no impact on the performance of the Emotional Stroop task and vice versa. However, there is a negative trend of the errors made in naming the Physical Threat words at Time 1 is associated with a lower level of loneliness at Time 2, see Figure 3.23. The cross section results of Time 1 data showed that lonely individuals tended to make more errors in naming the Neutral, Physical Positive and Social Positive words. Taken the findings from the longitudinal study, the results suggested that loneliness may be associated with an attentional biased that favours Physical Threat information.

Because the error made in the emotional Stroop task is associated with impulsivity, Physical Threat words, due to its negative valence, may have a stronger effect in trigger an impulsive response in general. Therefore, participants making more errors in naming Physical Threat words at Time 1 tend to be less loneliness at Time 2 may linked to the impulsive response, whereas individuals failed to do this may be associated with maladaptive attentional process that favours the negative physical information.

Figure 3.23 A structural equation model of cross-lagged emotional Stroop Errors and Loneliness effects with regression parameters.



Cross-lagged panel model results of loneliness scores errors of naming different categories of words in Emotional Stroop task

Note. Red line indicates a positive effect, blue line indicates a negative effect. The more errors made when naming the Physical Threat words in the emotional Stroop task at Time 1 predicted a decrease of loneliness level at Time 2.

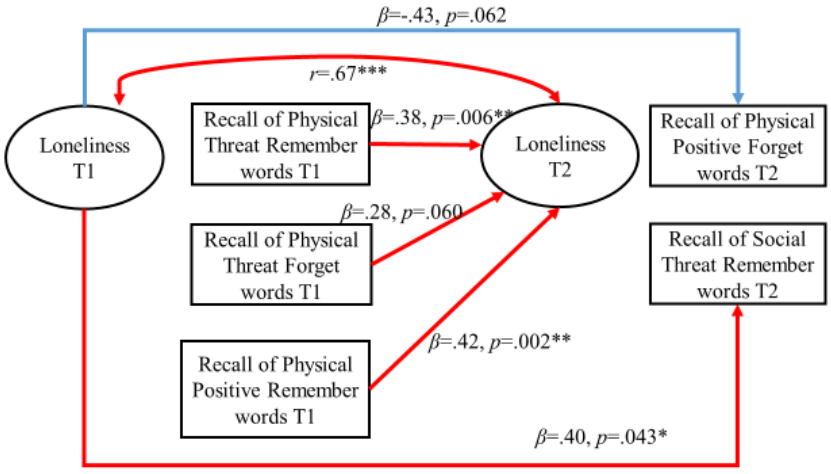
Directed Forgetting Task

Recall.

Scoring of Recall. The proportion of words remembered for the five word categories (Neutral, Social Threat, Social Positive, Physical Threat, and Physical Positive) in the two instruction conditions (Remember and Forget) was computed. The Proportion of forget words recalled out of all words recalled in each word category was also computed.

Cross-lagged analysis results for Recall. The results of the cross-lagged model were shown in Figure 3.24. There was a significant cross-lagged effect of loneliness on the recall of Social Threat remember words (β = .40, p = .043*). Moreover, there were significant positive cross-lagged effects of the Recall of the Physical Threat Remember Words (β = .38, p = .006**) on participants' Loneliness level and of the Recall of the Physical Positive Remember Words (β = .42, p = .002**) on participants' Loneliness level. The results showed that the participants with a higher level of loneliness at Time 1 remembered more Social Threat Remember words at Time 2. Reciprocally, individuals who recalled more of the Physical Threat Remember words and the Physical Positive Remember words at Time 1 tended to have higher levels of Loneliness at Time 2.

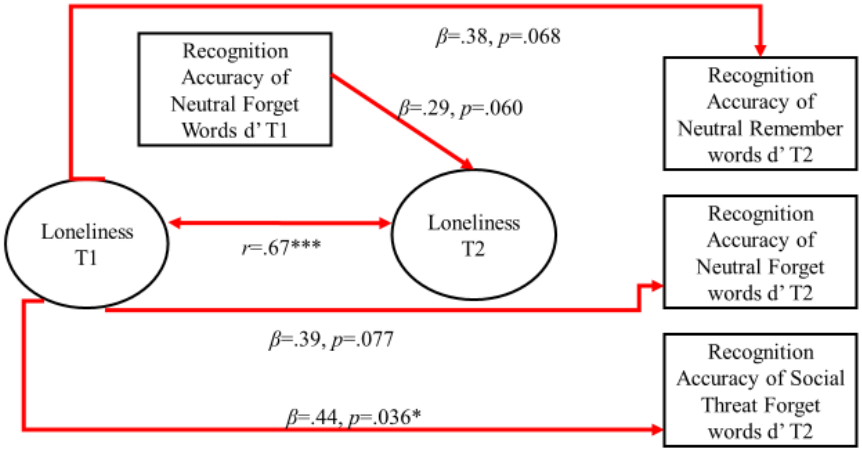
Figure 3.24 A structural equation model of cross-lagged Directed Forgetting Recall and Loneliness effects with regression parameters. Red line indicates a positive effect, blue line indicates a negative effect



Note. The results suggest that a higher level of loneliness at Time 1 predicted a better recall of Social Threat Remember words at Time 2. On the other hand, a better recall of Physical Positive Remember words at Time 1 predicted a higher level of loneliness at Time 2.

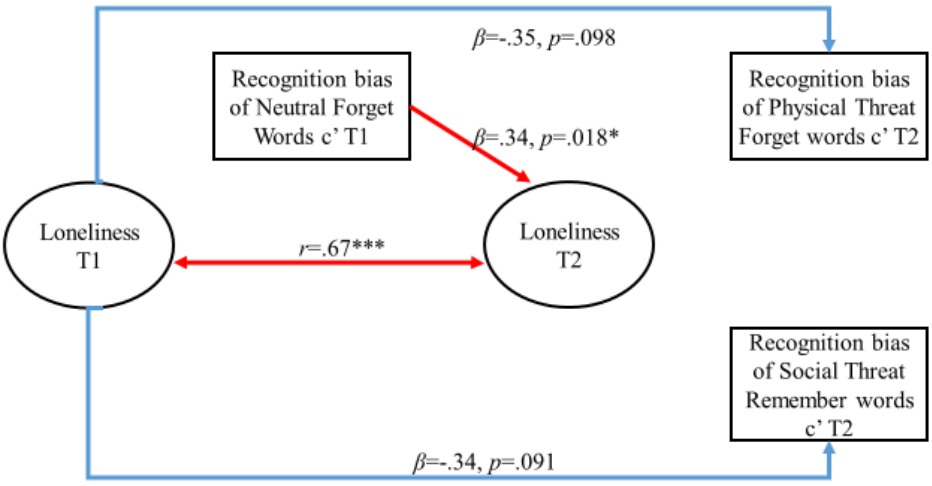
Recognition. The results of the cross-lagged model for recognition accuracy were shown in Figure 3.25, and recognition biases in Figure 3.26. The results showed that there was a significant cross-lagged effects of Loneliness score on a better recognition accuracy of Social Threat Forget words (β = .44, p = .036*). However, there was a significant effect of the recognition bias of Neutral Forget words on loneliness level (β = .34, p = .018*). This suggests that individuals who tended to give more No answers to Neutral Forget words at Time 1 tended to have higher level of loneliness scores at Time 2.

Figure 3.25 A structural equation model of cross-lagged Directed Forgetting Recognition Accuracy and Loneliness effects with regression parameters. Red line indicates a positive effect, blue line indicates a negative effect



Note. A higher level of loneliness at Time 1 showed a better Recognition of Social Threat Forget words at Time 2.

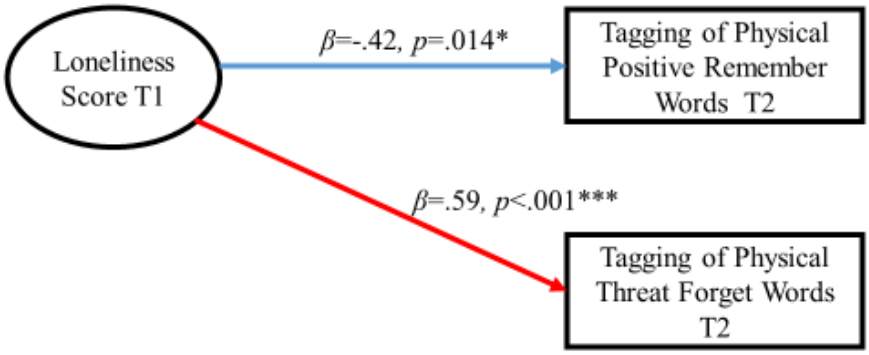
Figure 3.26 A structural equation model of cross-lagged Directed Forgetting Recognition Bias and Loneliness effects with regression parameters. Red line indicates a positive effect, blue line indicates a negative effect



Note. Individuals who gave more No answer to Neutral Forget words at Time 1 tend to have a higher level of loneliness at Time 2.

Tagging. The cross lagged results of loneliness and tagging performances were shown in Figure 3.27. The results revealed a positive cross-lagged effect of participants' Loneliness Level on the tagging of the Physical Threat Forget Words (β = .59, p < .001**), and a negative cross-lagged effect of Loneliness level on the tagging Physical Positive Remember words (β = -.42, p = .018*). The results suggested that participants with higher levels of Loneliness at Time 1 tended to tag the Physical Threat Forget Words better but tagged Physical Positive Remember words poorly at Time 2.

Figure 3.27 A structural equation model of cross-lagged Tagging Accuracy and Loneliness effects with regression parameters. Red line indicates a positive effect, blue line indicates a negative effect



Results of cross-lagged analyses of loneliness scores at T1 and the tagging outcomes of each categories of words

Note. A higher level of loneliness at Time 1 predicted a poorer tagging of Physical Positive Remember words at Time 2 but a better tagging of Physical Threat Forget words at Time 2.

Conclusion of the Cognitive Study

The results of the cognitive study suggest that loneliness is associated with attentional and memory biases towards irrelevant emotional information. Moreover, loneliness and cognitive biases affect each other reciprocally. Therefore, cognitive biases may be an important feature of loneliness, and it may play an important role in the development and maintenance of loneliness. The summary of the results of the cross-section and longitudinal cognitive study are shown in Table 3.19 and 3.20.

Table 3.19. *The results summary of cognitive study at two time points concurrently*

Task	Testing for	Results Time 1	Results Time 2	Conclusion
Serial Recall	Attentional Bias and short-term memory/attentional control/processing of irrelevant information	Loneliness is associated with the trend of having a better Serial Recall performances for the Social Threat and Physical Threat condition.	A higher score of loneliness is related to a better correct recall of digits for the Silent condition and the Physical Threat condition.	1. Lonely individuals showed better task execution when the to-be-ignore information are presented aurally (Serial Recall task), but a worse task execution when the to-be-ignored information are presented visually (emotional Stroop task) 2. Lonely individuals showed better performance than non-lonley individuals when the to-be-remembered information differed categorically from the to-be-ignored information (Serial Recall task); but they showed a poorer attentional control when the to-be-studied information and to-be-ignored information are presented in the same sensory channel (Emotional Stroop).
Emotional Stroop	Attentional Bias/ Automatic attention/ processing of irrelevant information/ filtering	A higher level of loneliness is related to a longer reaction time in naming Neutral words, Physical Positive words, Social Positive words and Social Threat words. A higher level of loneliness predicted more colour naming errors made in Neutral words, Physical Positive words and Social Positive words.	No significant effects were found.	
Directed Forgetting Recall	Short Term Memory/ Memory bias/ Processing of irrelevant information	Higher level of loneliness are related to a better recall of social threat remember words.	A higher level of loneliness is related to a better recall of social threat remember words.	Only this result is consistent across the two time points. Therefore, loneliness is related to a positive memory bias for social threat words.

Table 3.20. *The results summary of the cross-lagged longitudinal model for the cognitive study*

Serial Recall
Loneliness Time 1 → Proportion of correct items recalled in Silent condition Time 2 Loneliness Time 1 → Proportion of correct items recalled in Physical Threat condition Time 2
Emotional Stroop
Number of errors made when naming the Physical Threat words Time 1 → Loneliness Time 2
Directed Forgetting
Recall
Loneliness Time 1 → Recall of Social Threat Remember words Time 2
Loneliness Time 1 → Recall of Physical Positive Forget words Time 2
Recall of Physical Threat Remember words Time 1 → Loneliness Time 2
Recall of Physical Threat Forget words Time 1 → Loneliness Time 2
Recall of Physical Positive Remember words Time 1 → Loneliness Time 2
Recognition
Recognition accuracy d’
Loneliness Time 1 → Neutral Remember words d’ Time 2
Loneliness Time 1 → Neutral Forget words d’ Time 2
Loneliness Time 1 → Social Threat Forget words d’ Time 2
Neutral Forget words d’ Time 1 → Loneliness Time 2
Recognition biases c’
Loneliness Time 1 → Physical Threat Forget words c’ Time 2
Loneliness Time 1 → Social Threat Remember words c’ Time 2
Neutral Forget words c’ Time 1 → Loneliness Time 2
Tagging
Loneliness Time 1 → Tagging of Physical Positive Remember words Time 2
Loneliness Time 1 → Tagging of Physical Threat Forget words Time 2

Note. A red arrow indicates a positive effect, a blue arrow indicates a negative effect.

Discussion

Attentional Control and Short Term Memory in Transient Lonely Individuals

The results showed that the cognitive bias in lonely individuals is complex and multi-dimensional. Both the attentional and memory processes in lonely individuals were different from non-lonely individuals. With regard to attentional processes, individuals with a higher level of loneliness scores showed a slower automatic attentional and strategic processing of visual irrelevant stimuli (emotional Stroop task); but enhanced serial recall performance when the background speech comprised physical threat or social threat words (Serial Recall task). For memory processes, individuals with a higher level of loneliness exhibited a heightened memory bias of Social Threat Remember words.

These findings are in line with previous studies that have demonstrated an attentional bias for social threat information for lonely individuals, but most prior findings relate to automatic attentional processes only (for example, Bangee et al., 2014; Cacioppo et al., 2015; Qualter et al., 2013). The current study also demonstrates that lonely individuals' allocation attention differed based on the type of the task. When the focal task involves both auditory and visual processing (Serial Recall task), high lonely individuals showed an advance performance against the Physical and Social Threat sounds. When the focal task involves shifting attentional resources between the same sensory channel, i.e. emotional Stroop task and Dichotic listening task, lonely individuals showed poorer attentional control. One of the possibility of this effect is that lonely individuals may be more vigilant in visual stimuli processing in comparison to non-lonely individuals, as it linked to the brain activation pattern towards threat materials of lonely individual's differed from non-lonely individuals. Brain imaging and eye tracking studies have both found that lonely people spend longer viewing socially threatening images or video, and their brain differentiates those stimuli quicker than other stimuli (Bangee et al., 2014, Cacioppo et al., 2015, Qualter et al., 2013).

Another explanation is that the lonely individual lack of attentional control (e.g. slower reaction time in naming the colour of all words in the emotional Stroop task) in processing conflicting information presented in the same object. This finding is in line with previous research, Cacioppo et al. (2000) used a dichotic listening task

to examine the attentional control in lonely individuals. They found that in right ear advantage individuals (individuals who are right handers and processing information better in their right ear compare with left ear), lonely individuals outperformed non-lonely individuals in naming the consonant vowel pairs correctly when there were no instruction given, or when the instruction were given to focus on their right ear. However, they perform worse than non-lonely individual in identifying the incoming sounds when they were given the instruction to focus on the left ear. The results suggested that lonely individuals are impaired in attentional control when the voluntary processing (focus on left ear) conflicted with automatic processing (focus on right ear).

Taken together, the findings from the Serial Recall and emotional Stroop task indicate that lonely individuals tend to have a complex attentional mechanisms when processing irrelevant information, suggesting a maladaptive cognitive and behavioural alteration which may impact on their processing of everyday events, and particularly, social events (Spithoven, 2017).

Transient Loneliness and Encoding and Retrieving of Information

The current study is the first study to examine explicit memory and inhibition of social and non-social information and loneliness at a given time point and across time points. Lonely individuals showed an enhanced recall of Social Threat information at the two time points. Moreover, a longitudinal effect was also observed that a higher level of loneliness predicted a better recall of Social Threat Remember words at T2. The study demonstrated that lonely individuals have an explicit memory bias for the Social Threat information. This finding is in line with Gardner et al. (2005) who found that loneliness is associated with a better recall of social events in a diary study. The current study suggests that lonely individuals remembered more individual Social Threat words amongst other categories words that were being told to remember. Such memory bias may have a causal effect on the maintenance of loneliness: for example, perhaps a heightened recall of socially threatening information may perpetuate the belief that people are hostile and unfriendly (Cacioppo & Hawkley, 2009).

The current study also indicates that general memory function in lonely participants is enacted. Previous literature suggests loneliness leads to cognitive

function decline, including a poorer immediate recall and delayed recall (Boss, Kang, & Branson, 2015). Considering most of the studies that have found memory impairment of lonely individuals included participants who were of old age, although the current study did not report the same findings, it may provide insights for the link between loneliness and poor cognitive functions at old age. Because the memory bias of socially threatening information may result in a poorer ability to encode and recall other categories of information across time, it may results in memory deficits in old age.

Loneliness-Cognitive Processing: Prospective Relationships

The results showed that loneliness was found to be stable over time. Previous studies state that the stability of long-term loneliness across 1 to 3 years is between .38 to .68, while studies of short-term loneliness show that the correlation between loneliness of across 6 to 11 weeks is between .71 to .85 (Heinrich & Gullone, 2006). The correlation of loneliness of the current study at the two time points appears to be stable across 10 months, with a correlation of .67 although this is only applied to a small sample size.

Loneliness, attention and memory processes over time. The cross-lagged effect in the current study showed that loneliness not only affects cognitive processing concurrently but also affects it over time. The results are also reciprocal, wherein certain cognitive processing predicts increases in loneliness over time.

For example, in the recognition phase of Directed Forgetting task, a high level of loneliness at Time 1 predicts better recognition of Social Threat Remember words at Time 2. On the other hand, participants who recalled more of the Physical Threat Remember words and the Physical Positive Remember words at Time 1 tended to have higher levels of Loneliness at Time 2.

As a whole, the results indicate that lonely individuals become more proficient in avoiding of threat in their attentional regulation, and remembered more Social Threat information across time. The current study only measured a lapse of 10 months between the two test points, however, the results are striking. Therefore, it is reasonable to argue that the contribution of loneliness on attention and memory processes is chronic and significant.

Because the attention and cognitive biases are related (for example, Blaut et al., 2013), the results suggested that loneliness may have an impact on not one, but in all stages and all levels of cognitive processing. It is possible that these cognitive biases may affect higher order executive functions, such as judgement and decision making, and play an important role in the development and maintenance of loneliness. Moreover, the findings may also shed light on the way loneliness modulates the brain processing of visually presented cues (Cacioppo et al., 2009; Cacioppo et al., 2015; Kanai et al., 2012), self and social perception (Nakagawa, et al, 2015), poorer social functioning (Cacioppo & Hawkley, 2009), and lead to a withdrawn behavioural pattern (Qualter et al., 2015).

It is worth noting that the effect of cognitive processes on loneliness is only evident for physical words which are exhibited in the longitudinal results of Directed Forgetting task. Although one previous study that examines the memory function and loneliness longitudinally found that poorer memory function contributes to a higher level of loneliness in 4 years' time the loneliness score did not predict an impaired memory function chronically (Ayalon et al., 2016). However, this study used a general psychological questionnaire to measure individuals' memory function, which is different from the current study design. Moreover, although the cross-lagged effect of loneliness on memory bias is not significant, they found that loneliness is associated with a lower memory function at the time of participation. Thus, the difference in results may be related to the differences in the memory function being measured, but still demonstrating a significant link between loneliness and memory function.

The results showed that participants who recalled more of the Physical Threat Remember words and the Physical Positive Remember words at Time 1 tended to have higher levels of Loneliness at Time 2. Physical threat words may induce biological threat which links to a visceral fear response in most individuals (Wright, Kelley, & Poulin-Dubois, 2014). In Cacioppo et al's (2015) brain imaging study, it appears that early activation of brain microstates was not only found in viewing social threat images but also in physical threat images. However, the areas of the brain activated were different when processing these two types of images. When processing social threat pictures, the brain area activated in lonely individuals were

areas that are associated with attention, self-representation and threat. When processing non-social threat pictures (e.g., of snakes), the brain area activated was related to biological motion perception, face perception, and episodic memory (Cacioppo et al., 2015). In lonely individuals, these heightened fear responses may also help to develop and maintain loneliness in the long term. Van Roekel et al. (2010) conducted a study to examine the genotype of loneliness and the results showed that overactivation of the amygdala in response to fearful stimuli may be associated with the development of loneliness. Therefore, the findings of this study might indicate that the frequent activation of biological motion perception may trigger the feeling of loneliness and perpetuate the feeling.

Moreover, loneliness is also associated with the increased activation of the hypothalamic pituitary adrenal (HPA) axis, which regulates the stress response, and diminished sleep quality (Cacioppo et al., 2000). Most previous studies argued that this was driven by the chronic activation of social threat surveillance in social situations. The current findings suggest that that the surveillance might also occur for physical threat information that links to the bodily response of fear. The frequent and prolonged activation of bodily response of fear may lead to increased anxiety (Johnson, LaVoie, Spenceri, & Mahoney-Werni, 2001; Jones, Rose, & Russell, 1990) and rumination (Vanhalst, Luyckx, Raes, & Goossens, 2012), and it may result in the heightened activation of the HPA axis and diminish sleep quality (as proposed in Cacioppo & Hawkley's 2009 model). Such hypersensitivity to physical information might cause the frequent activation of the HPA axis and cause the person to become more vulnerable to developing loneliness.

The results are in line with previous research and loneliness and cognitive biases affect each other reciprocally. Cognitive biases have been linked to the development and maintenance of many emotional disorders, for example, depressive symptoms (Gotlib & Joormann, 2010) and social anxiety (Clark, 2001). However, few longitudinal studies have been undertaken to examine the impact of loneliness on the cognitive bias across time and vice versa. The current study is the first to identify the reciprocal relationship between loneliness and cognitive biases.

Limitations and Future Directions

There are some limitations to the current study, which means the results should be interpreted with caution. The loneliness scores in this sample were lower than those reported in other studies. The number of people scoring very high on loneliness was small. Therefore, we cannot draw many conclusions about the longitudinal impact of cognitive process in an extremely lonely population based on the present sample. The upper limit of loneliness that we would define as 'extreme' varies considerably between studies (for example, Cacioppo et al., 2002, Qualter et al., 2013a). In addition, the study included people from a wide range of ages and that may limit our understanding of differences across those groups cross-sectional and longitudinally. Given that cognitive and behavioural biases may look different for lonely people at different developmental stages (Qualter et al., 2015), it will be important, in future studies, to examine the prospective associations between cognitive biases and loneliness across ontogeny.

Furthermore, the current study only studied attentional biases when the emotional contents were task irrelevant. The attentional control were not studied when the focal task involves processing of the emotional content (for example, in the Serial recall task, the to-be-remembered items being the social threat words). Therefore, future studies should design tasks focus on studying the attention and memory of emotional information, whilst ignoring the same category of emotional contents.

Moreover, future studies should examine the implicit memory of social and non-social information in transient and chronically lonely individuals. The memory tasks used in the current study, such as free recall and recognition, were designed to measure individuals' ability to recollect epiosidc memory for the information. However, these types of tasks cannot assess individuals' previously learnt information. Implicit memory involves priming and retrieving of learnt skills that may be associated with lonely people's cognitive bias. Future studies should consider using implicit memory tasks, such as word stem completion, word-fragment identification, to examine whether lonely individuals may retrieve task-irrelevant negative memories.

Chapter 4. Observational Study: Loneliness and Social Interaction in Female Friendship Dyad

Introduction

Many studies that ask people to self-report on their social relationships show that lonely people have social skills deficits. However, there are few observational studies that have investigated the actual social behaviour of a lonely person. Without such objective examination of social interaction, claims that lonely people have social deficiencies are problematic: it is possible that the negative self perceptions of lonely people contribute to their negative appraisals of themselves as effective social beings, but that their actual behaviour during social interactions is comparable to non-lonely people.

The current study aims to fill that gap in the literature by using the observation method to explore lonely individuals' actual social behaviour, alongside their perceptions of their social interactions. Of particular interest was the close social relationships of lonely people and so these social behaviours and perceptions were examined when lonely people engaged with their best friend. 58 female dyads (116 participants in total) took part in a social interaction study, with behavioural interactions being coded on a number of dimensions. During the observed sessions, participants discussed four questions about friendship with one of their friends for 15 minutes. Thereafter, individuals filled in questionnaires that asked about what they thought of the quality of the social interaction they had just had, friendship quality, and their levels of loneliness.

The observed social interactions were filmed and a series of verbal and non-verbal behaviour were blind coded. The data were analysed by using the Actor Partner Interdependence Model in SPSS AMOS. The results show that lonely females gazed less at themselves, gazed less at their partner's body, and were less responsive towards their friends. Friends of lonely females asked more open-ended questions, but showed an increasing amount of disengagement from the interaction, with increased sighing and less looking at the face of the lonely friend. Both lonely people and their friends perceived each other negatively, but individuals who had been in their relationships with lonely people for longer tended to see lonely people

more positively. The findings confirm that individuals with higher level of loneliness scores tend to have negative social interactions in general, and receive reciprocal negative responses from their friends.

Loneliness and Social Behaviour

According to empirical research, feeling lonely often leads to withdrawal from social relationships (Qualter et al., 2015). In previous research, individuals who said they felt lonely usually acted in a self-absorbed manner in social interaction, tending to be passive, shy, withdrawn, and socially inhibited (Bell, 1985; Chelune et al., 1980; Jones et al. 1982; Solano et al., 1982). People who had interacted with someone who felt lonely also reported their partners as "difficult to get to know", and saw them as less attractive social companions (Jones et al. 1983). While that work is important and provides evidence that lonely people behave in a more withdrawn way, for the effective development of interventions, one needs to know specifically what happens in the social encounter that leads to withdrawal (or, is lack of engagement there from the outset) and what other behavioural characteristics are also evident that might make social withdrawal more likely. Also, previous research often ignores the fact that social interaction is a process between two people and that interaction partners influence each other throughout that social encounter: knowing how interaction partners respond to actions of the lonely person is important for understanding how we might intervene to develop effective interaction if appropriate.

One of the important behavioural manifestations related to loneliness is perceived poor self-disclosure. Findings in this area are consistent and sufficient to summarise that lonely individuals tend to disclose less in the interaction, and their disclosure were less intimate compare with non-lonely individuals.

Loneliness and self-disclosure. People who report feeling lonely are not effective communicators. During social interaction, lonely university students give less intimate and less reciprocal disclosure about themselves either in face-to- face (Mahon, 1982; Solano et al., 1982) or online communications (Leung, 2002). Chronic loneliness is also associated with less disclosure of recent positive experience (Arpin, 2015). Lonely individuals reported their disclosure as lack of intimacy when evaluating their own interaction with a same sex-friend (Wittenberg

& Reis, 1986), an opposite sex friend (Solano et al., 1982), and when they interacted with an opposite sex stranger (Jones et al. 1982). Moreover, individuals who feel lonely tend to choose an inappropriate self-disclosure topic with a potential social partner, which may reduce the intimacy in their social relationships (Solano, et al., 1982).

The ability to reveal one's feelings and thoughts to others is a basic skill for developing and maintaining social relationships (Altman & Taylor, 1973), and positive self-disclosure has also been linked with alleviating feelings of loneliness and subsequent depression (Wei et al., 2005). Most of the research examining loneliness and self-disclosure was conducted in the 1980s; some of the work uses observational methods, but most of the research relied on self-reported questionnaires. No research on self-disclosure examined the behaviour of the partner – did he/she also disclose less, and how was it linked to other behavioural characteristics. Although previous research found that loneliness was explained by attachment anxiety, social self-efficacy and self-disclosures (Wei et al., 2005), most of these studies relied on subjective self-report questionnaire, rather than objective observation. Moreover, more recent research has examined self-reported social behaviour and social perceptions amongst the children and adolescence sample (for example, Woodhouse et al., 2011; Schinka et al., 2013; Coplan et al., 2013), but comparable research involving an adult sample is lacking.

Because feeling lonely triggers feelings of social inferiority, fear of rejection, and self-blaming for social failure (Cacioppo & Hawkley, 2009), it is likely that lonely people report their social behaviour in a negative fashion in self-report questionnaires. Many researchers argue that lonely people merely perceive they have poor social skills, but they do not demonstrate those same social skills deficits in experimental studies (Solano & Koester, 1989; Knowles, Lucas, Baumeister, Gardner, 2015). Therefore, studies with self-reported measures of social skills may not reflect individuals' social skills accurately. Through work conducted with the observational approach, objective ratings of one's social skills and social behaviour can be made and these may distinguish between individual's perceived and actual social behaviour.

Loneliness and non-verbal behaviour. Most of the studies that have investigated loneliness and social relationships focus on talking behaviour or self-disclosure; few studies have examined lonely individuals' non-verbal behaviour. Because social behaviour consists of a wide range of parameters including not only verbal but also non-verbal behaviour, non-verbal behaviour is an important indicator of the degree of conversation involvement between individuals in a social setting (Patterson, 1982). Non-verbal behaviour such as gaze, body orientation, leaning towards partners, facial expressiveness, head nods etc. have been used in a great number of studies to examine the conversation involvement of members of dyadic relationships (Patterson, 1982). Therefore, it is important to take non-verbal behaviour into account when examining one's social behaviour and social relationships. Below, I discuss key non-verbal behaviour that have been shown to be important for social communication within dyadic relationships, and I examine whether there is evidence for individual differences in those behaviour as a function of loneliness.

Loneliness and eye contact. Eye contact is an important parameter in social interaction. It is unclear how individuals who feel lonely maintain eye contact in their social interactions. Eye contact and gaze in social interactions serve the purposes of providing information, expressing intimacy, facilitating effective communication (Kleinke, 1986), and show one's focus of attention (Raita, 2014).

In an eye tracker study that examined the eye gaze pattern when watching a playground video, lonely young adults tended to gaze more at negative social scenes, but quickly disengaged from them (Bangee et al., 2014), but lonely children found it difficult to disengage from such stimuli (Qualter et al., 2013). The results of the cognitive study in the current thesis showed that individuals with a higher level of loneliness scores did not show hypervigilance to auditory stimuli, but they reacted slower when viewing both social and non-social words when these words were presented visually in the emotional Stroop task. Extending the work of Bangee et al., and Qualter et al., Lodder, Scholte, Goossens, Engels and Verhagen (2015) found that, in an actual social interaction, lonely people exhibit a heightened level of social monitoring in the conversation about the on-line game 'Second-Life', but they did not exhibit heightened face gaze at their partner in another conversation about favourite TV shows (Lodder et al., 2015). Moreover, one study examined the self-

report loneliness and prosocial tendency found that loneliness may play a positive role in some aspects of the social functioning (Huang, Liu & Liu, 2016).

Thus, there is some evidence that lonely people who have been shown to be hypervigilant to negative social information or shown a tendency of showing more prosocial behaviour, they may extend that behaviour to be vigilant in actual social interaction, in the form of heightened social monitoring of the interaction partner.

So far, there are not many studies showing the consistent pattern of lonely individual's eye gaze pattern, and only one study detailed above that examined eye gaze during social interaction. The current study aims to fill that gap by coding the eye gaze pattern by lonely people and their friends during a social encounter.

Loneliness and partner attention. Previous empirical studies have established that lonely people are not desired social partners. In a mixture of self-report (Coplan et al., 2013.; Lodder, et al., 2016; Moroń, 2014; Tsai & Reis, 2009; Woodhouse et al., 2011) and direct observation studies (Qualter & Munn, 2002), lonely people appear to lack conversational skills and are not be perceived positively by their friends or strangers. Some observational studies conducted in the lab demonstrated that lonely people had poorer conversation involvement, devoting less attention to their conversation partners during social interactions (Bell, 1985; Jones et al., 1982); lonely people were also less responsive to their partner, showing less concern of the other person and acting in a self-absorbed manner (Jones et al., 1982). Similar findings come from work conducted by Bell (1985) who showed that lonely individuals were less talkative and produced fewer interruptions in conversations during their study. A greater sense of loneliness is also related to negative self-reports of their friendship (Lodder et al., 2015), and negatively correlated with both prosocial and disruptive behaviour (Woodhouse et al., 2011).

The consequence of this type of communication behaviour is that lonely people are difficult to get to know, and research supports the thesis that lonely people are perceived by others as less attractive for friendships. But, the observational research noted above examined partner attention between a lonely person and a stranger, only. It may be the case that, while the lonely person engages less in conversation with a stranger, it is not the case that they engage in less

conversation with a friend when they have developed a friendship. The social behaviour between lonely people and their friends using direct observation method is currently missing from the literature and the current study aimed to fill that gap.

Dominant and sadness behaviour. According to previous studies, lonely individuals, particularly lonely females may be more likely to show both dominant and sadness behaviour in social interactions. For example, females with a higher level of loneliness scores, as opposed to lonely males, scored higher on both submissiveness and dominance scales than non-lonely females (Check, Perlman & Malamuth, 1985). Loneliness has also been positively correlated with Machiavellianism in a previous study, indicating a constrained, unfriendly, and manipulative style of communication (Bell & Daly, 1985). The correlation between loneliness and Machiavellianism was found to be stronger in females (r = .40) than in males (r = .22). Machiavellian behaviour may be a way of controlling the social environments, which for lonely people are unpredictable and potentially threatening (Qualter et al., 2015).

Sadness has also been proposed as a likely behavioural cue employed by lonely people, as one may be seen as lonely if they look sad around other people (Luhmann et al. 2016). According to the evolutionary model of loneliness (Cacippo & Hawkley, 2014), people look sad when they are lonely so that people will engage them in social activity: sadness is proposed to be an evolutionary mechanism that increases social engagement.

Where observational studies have been conducted, they show that lonely adults are perceived by their partners as wanting to influence others less and preferring a more structured, rigid relationship (Jones, et al., 1981). That suggests lonely people may be less hostile during interactions, less likely to direct conversations, and may tend to be more agreeable during social interaction. That finding seems to contrast with those from studies noted above that include self-reports of dominant and manipulative social behaviour of lonely people. No observation research exploring the behavioural profile of lonely people has looked at cues depicting sadness during observed social encounters. Thus, the use of observational methods to explore dominance and sadness of lonely people in social encounters is needed. Such work will inform intervention strategies that may want to

focus on any social skills deficits or social behaviour of the lonely person that 'puts people off' interacting with them.

Loneliness and Perceptions of Social Relationships

A series of studies examining judgments of self and others following interactions among unacquainted college students has provided modest support for the hypothesis that loneliness affects an individual's social perceptions. Loneliness is related to a negative perception of self and the social world in general. However, friends or people who have interacted with lonely people tend to perceive lonely people differently, and often in a more positive way.

Perceived rejection. Research reaches a consensus about lonely individuals' perception of their social world. Most of that research suggests lonely individuals' perceptions regarding their social relationships are generally negative: they tend to view themselves negatively, view other people negatively, and expect other people to rate them negatively when compared with non-lonely individuals (for example, Jones et al, 1981, Jones et al, 1982, Jones et al, 1983, Wittenberg & Reis, 1986). Lonely individuals also tend to hold that negative view about their social interactions across time (Duck, Pond & Leatham, 1994). In addition, they report their interactions with other people as not being intimate compared with those of non-lonely individuals (Jones et al, 1981, Williams & Solano, 1983).

Others' perception. Although lonely individuals expect other people to rate them negatively, the findings of studies looking at what other people think of lonely people tend to vary. Loneliness is viewed as a social stigma, with empirical studies showing that other people tend to perceive people who fulfil the lonely stereotype as lacking psychosocial function, preferred them less as a potential friend (Lau & Gruen, 1992; Rotenberg & Kmill, 1999). Previous studies suggested that when people are told their interactive partner is lonely, they rated that partner as less attractive, less sincere and more passive (Lau & Gruen, 1992).

While some studies showed that interaction partners sometimes reported unfavourable impressions of lonely people, it is not always the case (Solano & Keoster, 1989). For example, Jones, Sansone, and Helm (1983) found that lonely males were rated negatively compared with non-lonely males, but lonely females, on

the other hand, were not rated differently by their opposite sex dyadic partner. Both lonely males and lonely females were perceived by others as rating themselves negatively. Another study conducted by Jones, Hobbs, and Hockenbury (1982) revealed no differences in how interactive partners viewed lonely and non-lonely people.

Perceptions of friendship quality. Some research provides evidence that loneliness is related to lower perceived friendship quality (Nangle, Erdley, Newman, Mason & Carpenter, 2003, Qualter & Munn, 2002). However, it is unclear from that work whether friends of lonely people report a negative friendship quality reciprocally. A recent dyadic best friend study with adolescents explored that question, revealing that lonely adolescents had fewer friends, as perceived by themselves and their peers (Lodder, Scholte, Goossens & Verhagen, 2015), and when reporting on their friendship quality with their best friends, lonely individuals reported a lower level of friendship quality, but their best friend did not report experiencing a low quality of friendship with that lonely person. However, findings in this area of research are limited to that one study, so further work is needed to examine friends' perceptions of lonely people to complete the social profile of lonely individuals.

Most of the studies focusing on loneliness and friendships studied children and adolescents, with few exploring friendships and loneliness among adults. Friendships are an integral part of human experience, through childhood to old age, with healthy friendships an essential part of our social lives (Colarusso, 1994). Thus, it is important to investigate friendship qualities in this group as this area is significantly under researched.

Gender difference between the evaluation of loneliness by a target and a perceiver. Although the perceptions by and of lonely people are negative in general, studies confirm a gender difference between the perceiver and the target (Lau & Gruen, 1992; Rotenberg & Kmill, 1992): lonely males were being rated more negatively than lonely females (Lau & Gruen, 1992) and female perceivers are more critical of lonely individuals (Lau & Gruen, 1992), and believed they were more deprived in psychosocial well-being (Rotenberg & Kmill, 1992).

Moreover, sex differences in social behaviour clearly distinguish between same-sex friendships. Compared with females, male relationships tend to have lower level of emotional intimacy (Williams, 1985) and emphasizes shared activities and interest (Caldwell & Peplau, 1982); conversely, female friendships are highlighted by talking about feelings and personal problems. Furthermore, both males and females believe females are more disclosing of their feelings as compared with males (Reisman, 1990). Women also report feeling more at ease when relating to other women than to men (Reisman, 1990).

To examine the effects of loneliness on social interaction and evaluation without confounding effects via the impact of gender, the current study focused on female friendships only. Because I wanted to examine self-disclosure, intimacy and involvement in social interactions during the current study, the recruitment of female participants only was thought to be appropriate. The behaviour and perceptions during interactions between male friends will be examined after the PhD, such that comparisons with findings from female-female friendship interactions can be made.

Friendship length. Friendship length is an important predictor of quality of friendships. Loneliness has been found to be negatively correlated with the average duration of a person's friendships (Geers, Reilley & Dember, 1998). Previous empirical work showed that lonely individuals were seen by new acquaintances and close friends differently. Lonely individuals are viewed by new acquaintances more positively in a group interaction (Christensen & Kashy, 1998), but they expect their close associates would rate them more negatively (Tsai & Reis, 2009). As mixed findings were yielded when examining individual's social perceptions by and of lonely people's social ties, more research need to be conducted in this area.

Rationale for the Current Study

Most of the studies noted above used self-reported measures of social skills to evaluate individuals' social behaviour and social perceptions. Because loneliness is related to intrinsic negative evaluation of oneself and judgments about performance during social interaction (Jones et al, 1982), findings from such self-reported studies may only reflect a subjective communication pattern rather than actual behaviour during social interactions. Therefore, more research using

observation methods is warranted, such that actual social behaviour of lonely people in social occasions is examined.

The current study used an observational technique to examine how feelings of loneliness influence actual social behaviour and perceptions for people in female-female friendships in a real life social interaction. The current study aimed to test the following:

1) The behavioural differences of lonely individuals and their friends in a dyadic social interaction.
2) The social interaction quality, friendship quality and the judgements by and of lonely individuals and their friends of each other.
3) The differences between the social behaviour and social perceptions in long and short friendship dyads.

Method

Participants

58 female friend dyads (116 women) who attended a university in the North West of England participated in the study. The mean age of the participants was *21.52 years (SD = 6.18;* age range was 18 to 49). Participants were recruited via flyers and campus-wide e-mail announcements. Interested female individuals signed up with one of their female friends for this study in exchange for course credits (6 SONA points) and a £5 Amazon voucher.

Dyadic Interaction Videotaping procedure

Upon arrival, both participants were taken to a medium sized room, where they were seated in front a camera. The researcher confirmed that the dyads were friends and explained the study in brief. The dyads were acknowledged that they would be filmed in this study. Participants were informed that if either one of the dyad decided to withdraw from the study, all of their video footage will be erased. After consent was granted from both participants, the researcher switched on the camera and the participants were told to have any conversation with their friend for 5 minutes. The purpose of this is for the dyads to get used to being filmed. Once the researcher left the room, all dyads started engaging in conversation.

After 5 minutes, the researcher returned to the room to deliver a paper with 4 questions and instructed the participants to discuss the questions for another 15 minutes. The questions were:

1) How would you make friends with other people?

2) What would make people approach you as a potential friend?

3) What makes you a good friend?

4) If you were going on holiday with the person you interacted with in this study, what would your holiday plan be?

The first three questions were questions regarding friendships. These questions were designed to increase individual's self-disclosure. The fourth question was a practical task to see how dyadic members worked together to discuss a holiday plan. The design of these questions was adapted from Leaper et al. (1995).

After the 15 minutes of discussion, the researcher returned to the room and terminated the filming. The participants were separated and asked to complete a series of questionnaires that evaluated the interaction quality and participants' personalities individually. The details of the questionnaires used in this study are listed in the next section.

Self-Report Inventory

Participant completed two post interaction questionnaires, and one friendship function questionnaire after completing their interaction.

Post interaction questionnaire 1 (Berry & Hansen, 2000). The first post interaction questionnaire was adapted from a study conducted by Berry and Hansen (Berry & Hansen, 2000). The questionnaire was designed to examine how each participant felt about the interaction in general. In this questionnaire, the participants indicate the extent to which they

(a) enjoyed the interaction,

(b) considered the interaction to be smooth, natural, and relaxed,

(c) would like to interact with their partner again,

(d) felt their partner had disclosed to them,

(e) felt they had disclosed to their partner,

(f) considered the interaction to be forced, strained, and awkward,

(g) felt they influenced the interaction,

(h) felt their partner influenced the interaction,

(i) considered the interaction to be intimate,

(j) felt the interaction was satisfying, and

(k) considered it to be pleasant.

Each item was rated on a Likert scale from 1 (not at all) to 8 (very much) (Berry & Hansen, 2000). Cronbach's alpha of the whole scale for the current study was 0.78.

Scoring of the questionnaire. The 11 items were grouped into 4 different dimensions of the interaction. The first dimension is quality, which was composed of items (a), (b), (c), (f), (j) and (k) which contains enjoyment, smooth/natural/relaxed, desire to interact again, or if the interaction is forced/strained/awkward, satisfaction of the interaction and pleasant. The second dimension of the interaction is disclosure; items in these categories include (d) and (e) which measures how much participants self-disclosed and how much they felt their partners had disclosed to them. The third dimension is engagement which consists of item (g) and (h). This dimension measures the extent to which participants feel they have influenced the interaction and how much they think their partner influenced the interaction. The last dimension is intimacy, which is measured by item (i). This dimension covers the extent of intimacy participants feel there was in the interaction. A higher score on each dimension represents a higher level of satisfaction of the interaction. Cronbach's alpha for the quality, disclosure and engagement subscale is .85, .98, .94 respectively. There was no Cronbach's alpha for the intimacy subscales as there was only one item in this measure.

Post interaction questionnaire 2 (Jones, et al, 1983). The second post-interaction questionnaire was adapted from Jones et al. (1983). This questionnaire was used to assess how people rate themselves and their partner's performance within the interaction. Participants were asked to rate the following questions on a 1 to 9 scale, with 1 representing bad/weak and 9 representing good/strong. The questions are:

1) How do you rate your performance in the interaction? (Self-view)

2) How do you rate your friend's performance in the interaction? (View of other)

3) How do you think your friend would rate your performance? (Other's view)

4) How do you think your friend would rate their own performance in the interaction? (Other's self-view). Cronbach's alpha of the scale in the current study was 0.95.

Scoring of the questionnaire. Each question represents an aspect of participant's evaluation of themselves and their friend's performance in the interaction. Therefore, the scores of each question was subjected to the analysis and examined individually. A higher score for each question represents a higher rating for themselves and their partner.

McGill Friendship Function questionnaire. The McGill Friendship Function questionnaire (Mendelson & Aboud, 1999) is a measure based on The Aboud & Mendelson's (1992) friendship questionnaire. It is based on the notion that the distinction between friends and non-friends is based on affection and satisfaction. Six related, but distinctive, friendship functions were measures (Stimulating Companionship, Help, Intimacy, Reliable Alliance, Self-validation and Emotional Security).

Scoring of the questionnaires. The questionnaire consisted of 30 items. Each of the six friendship functions consisted of 5 items. Each item was measured using a 9 point scale from 0 (representing never) to 8 (representing always). A higher score for each function represents a participant rating their friend as better at fulfilling that function. Cronbach's alpha for each subscale was: Companionship, .92, Help, .87, Emotional Security .82, Intimacy, .92, Self-validation, .91, Reliable Alliance, .88.

Loneliness and Other Measures

The Revised UCLA Loneliness scale (Russell, et al, 1980). The Revised UCLA Loneliness Scale (Russell et al., 1980) is a 20 item scale measuring "one's subjective feelings of loneliness as well as feelings of social isolation" (Russell et al., 1980). Participants were instructed to rate how often of each statement was a description of them on a Likert scale from 1 (Never) to 4 (Often). The score range of the questionnaire is 20 to 80. Higher scores indicate a higher level of loneliness. Example items include: "No one really knows me well", "I feel left out", and "I am unhappy being so withdrawn". Cronbach's alpha for the scale in the current study was 0.94.

The Centre for Epidemiologic Studies Depression scale (CES-D, Radloff, 1977). The CES-D scale is a 20-item scale designed to measure depressive symptomatology in the general population (Radloff, 1977). Participants were expected to score each item based on how often they felt that way during the past

week. Each item was rated on a Likert scale range from 0 (Rarely or none of the time [less than 1 day]) to 3 (Most or all of the time [5-7 days])). The range of scores for the questionnaire is 0 to 60. Higher scores suggest the presence of more depressive symptoms. Example items in this scale include: “I was bothered by things that usually don’t bother me”, “I felt that I could not shake off the blues even with help from my family or friends”. Cronbach’s alpha was 0.89.

The Brief Fear of Negative Evaluation scale (Leary, 1983). The Brief Fear of Negative Evaluation is a 12-item scale that assesses the degree to which people are apprehensive about being evaluated negatively. Instructions of the scale asked participants to indicate how characteristic each statement describes of them. Participants responded to each item using a 5-point Likert scale from 1 (Not at all characteristic of me) to 5 (Extremely characteristic of me). The score range for the questionnaire is 12 to 60. Higher scores on the scale indicate a higher tendency to be apprehensive at the prospect of being evaluated negatively (Leary, 1983). Example items in the scale include: “I worry about what other people will think of me even when I know it doesn’t make any difference”, “I am afraid that others will not approve of me”. Cronbach’s alpha was 0.92.

Observational Data

Coding software. All videos were transferred to a laptop to code using Observer XT version 10.5 (Noldus Information Technology, 2015). All behaviours were coded using the continuous sampling method.

Coders. Three coders were involved in the coding of the data. Coder 1 coded monitoring, domineering, stonewalling; coder 2 coded talking, sadness, and fear and tension; coder 3 was a research assistant who helped with coding behaviour that represented ‘interest’ only. Coding was conducted blind, such that participants’ questionnaire scores were unaware by all three coders.

The three coders studied created codes and the SPAFF coding scheme carefully. A practice coding session was run before the coders started coding video footage. Coding started when all three coders had the same understanding of each of the behaviours.

Intra-rater reliability and inter-rater reliability. Intra-rater reliability. Intra-rater reliability analyses were run to confirm whether the coders were coding the behaviour consistently throughout the whole period of the coding. Each coder was allocated three random selected dyads to recode all behaviour of that dyad after they had completed the coding. After completing the coding of all behaviour for both participants, the intra-rater reliability analysis was calculated for the two sets of observations. The intra-rater reliability for the whole video (including all behaviour of two participants) was measured using Cohen's Kappa's coefficient. The Cohen's Kappa's coefficient of the two observations should reach between .61 and .80 to achieve a substantial agreement, or between .81 to .99 to achieve an almost perfect agreement (Viera & Garrett, 2005). The current study accepted all Kappa's coefficient above .70 to ensure a good reliability.

The intra-rater reliability of all three coders is shown in Table 3.1 below.

Table 4.1. *Intra-rater reliability of all three coders in the coding of three observations*

	Kappa's Coefficient for the first video	Kappa's Coefficient for the second video	Kappa's Coefficient for the third video
Coder 1	.80	.80	.79
Coder 2	.78	.76	.76
Coder 3	.76	.75	.77

Inter-rater reliability. The inter-rater reliability was calculated to assess whether each coder maintained the same understanding of each behaviour throughout the coding. Coder 1 and 2 coded all categories of behaviour each (Monitoring, Talking, Interest, Sadness, Fear and Tension, Domineering, Stonewalling) in every 9 dyads. Coder 3 coded behaviour that represents Interest in all 9 dyads. Five videos in total were recoded and calculated for inter-rater reliability, accounting for 8.6% of the total number of the observations.

Each behaviour category was coded in a separate file. Coder 1 and coder 2 coded each behaviour in the same file. Kappa's coefficient was obtained for each behaviour category by comparing the two codings of each coder (for the Interest category, Kappa was run between coder 1 and coder 3, coder 2 and coder 3, the

average of the two Kappas was adopted for inter-rater reliability of Interest). The reliability of each of the behaviours is described in the following sections.

Table 4.2. *Inter-rater reliability of all three coders in the coding of the three observations*

	Eye contact	Interest	Talking	Domineering	Stonewalling	Sadness	Fear & Tension
Time point one	.76	.78	.81	.92	.90	No Kappa	.77
Time point two	.78	.80	.80	.93	No Kappa	No Kappa	.81
Time point three	.77	.80	.77	.75	.94	.89	.97
Time point four	.80	.83	.81	.86	No Kappa*	85	.77
Time point five	.78	.85	.80	.78	No Kappa*	No Kappa	.79

Note. No Kappa were calculated when the behaviour occurred fewer than 6 times. Although the coders did discuss these behaviour occurrences to ensure agreement. This also included the behaviour pouting as this occurred rarely (less than 6 times throughout the entire ten dyad sample).

Categories of Verbal and Non-verbal Behaviour in Social Interaction

Seven codes of behaviour were coded for the interaction. To focus on the intimacy and involvement of the social interaction, Talking, Eye Contact, Domineering, Stonewalling, Interest, Sadness, Fear and Tension were coded in the current study.

Talking. Talking refers to the conversation between participants. Contents of conversations include Self-disclosure, Discussing question 1 to 3 and Open-ended Questions.

Self-disclosure. Self-disclosure refers to behaviour where someone is talking about themselves or giving specific facts or describing their personal feelings. The content of self-disclosure was categorised into 5 levels, adapted from Leaper and colleagues (Leaper et al., 1995). Only self-disclosure level 1 (low level self-disclosure) and self-disclosure level 3 (medium level self-disclosure) were used in the current analyses as comparison between the two level of self-disclosure. Self-disclosure Level 1 was defined as expression of impersonal/public information about the self (e.g., "I‘ve been to Barcelona."). Self-disclosure Level 3 was defined as expression of medium level of personal information (e.g. “My friend didn’t support me when I was going through a difficult time”). ***Discussing question 1 to 3.*** Discussing Question 1 to 3 refers to when participants are discussing the question 1 to 3 given in this study (Question 1: How would you make friends with other people, Question 2: What would make people approach you as a potential friend, Question 3: What makes you a good friend), these questions were aimed at examining participants’ perspectives of friendship. ***Open-ended questions.*** Open-ended questions refer to questions that do not require a “yes” or “no” response and allows the partner to express herself in greater detail. e.g. “What do you mean?” “How did you feel when that happened?”

Monitoring (eye contact). Monitoring refers to individual’s eye contact during the interaction. The categories of monitoring include: looking at self, looking at friend’s face, looking at friend’s body (Non face) and looking at environment. ***Looking at self.*** Looking at self refers to participants looking at their own body, e.g. lap, arms, hands, etc. ***Looking at their friend’s face.*** Looking at their Friend’s Face was coded when participants were gazing at their interaction partner’s facial region.

Looking at friend's face include direct eye contact made by participants. ***Looking at their friend's non-face.*** Looking at their Friend's Non-face refers to participants looking at other parts of their friend's body but not their partner's face, e.g. looking at partner's shoulders, legs, shoes etc.

Sadness. The sadness code refers to behaviour that conveys the feelings of emotional distress, upsetting, vulnerability and pessimistic (Coan & Gottman, 2007). It includes sighing and pouting/sulking. ***Sighing.*** Sighing refers to sighs from the participants, especially deep sighs. ***Pouting/sulking.*** Pouting/Sulking was coded when participant pouted or sulked. It often happens when a person had been overlooked, rejected or when participants were not getting their own way.

Fear and tension. Function Fear and Tension communicates, usually involuntarily, fear, worry, anxiety, nervous anticipation, or dread (Coan & Gottman, 2007). The Fear and Tension code included the behaviour Fidgets. ***Fidgets.*** Fidget is a behaviour that is commonly adopted by fearful and tense individuals. The person may be shifting their positions in their chairs excessively, repeatedly pulling their clothes or hands, touching their faces or biting their lips inside and outside their mouth.

Interest. In the SPAFF, Interest is characterized as a positive valence behaviour that confirms the attention were focused to the conversation partner (Coan & Gottman, 2007). The Interest code included Head Nod and Leaning Forward. ***Head nods.*** Head Nods are when the individual is nodding her head and to show she is paying attention. ***Leaning forward.*** Leaning forward refers to when participants lean forward towards their partners.

Domineering. Domineering is exerting and demonstrating control over one's partner or conversation (Coan & Gottman, 2007). We also include another two behaviours for this category: Successful Interruption and Unsuccessful Interruption. ***Successful Interruption.*** Successful Interruptions are coded when an individual interrupts when their partner is talking. The result of the interruption was successful if their friend stops talking so the individual who interrupts can speak. ***Unsuccessful Interruption.*** Unsuccessful Interruptions are coded when an individual's interruption

was not successful. Their friend carries on talking or tells the individual attempting to interrupt them, to wait for them to finish.

Stonewalling. Stonewalling functions to communicate an unwillingness to listen or respond to the receiver (Coan & Gottman, 2007). The behaviour in this category is No Back Channels. ***No Back Channels.*** The stonewalling person does not offer vocal or non-vocal back channels in response to their partner. There are no head nods, no neck movement and no vocal or verbal agreements (as in "ummhummm," "yeah," "uh-huh," etc) or responses. The no back channel behaviour often occurs abruptly, as if the speaker is intending to distance their friends.

State Events and Point Events in the Observer Software. For state events, which refer to behaviour that are continuous, e.g. Looking at Friend's Face, Looking at Self, Leaning Forward, Fidgets etc., the duration of each moment of the behaviour was coded and calculated. Point events are those where the number of times each behaviour occurred was more important than how long it happened for, i.e. head nod, nervous gesture, open-ended questions etc., the number of times that behaviour occurred was coded and calculated.

For State Events, the duration of each behaviour per minute for each person is calculated. The formula to calculate this is: Total amount of duration of a behaviour ÷ 15 (minutes)

For Point Events, the number of times each behaviour occurred per minute for each participant is calculated. The formula to calculate this is Total number of occurrence of a behaviour ÷ 15 (minutes)

Data Transformation. Skewness and kurtosis were calculated to examine whether the data were normally distributed. For behaviour variables that were beyond the acceptable range of skewness (between -2 to 2, [George & Mallery, 2010]), data transformation was applied. Square Root and Log 10 transformation were applied to data that were not normally distributed. After transformation, the new variable that provides the minimum skewness and kurtosis level was subjected to analyses. Skewness and kurtosis examinations were completed for all observational data.

Analysis Plan

Actor–Partner interdependence model (APIM). The actor–partner interdependence model (APIM; Cook & Kenny, 2005) is a model that illustrates not only how the emotion, cognition and behaviour of a person has an effect on their own outcomes, but also how that variable affects their partner's outcome (Cook & Kenny, 2005). Traditional analysis (e.g. ANOVA, regression) assumes that each participant is independent, and the outcome of one person will not have an impact on the outcome of another person. For example, in the cognitive study in the current thesis, each participants' cognitive performances will not be affected by other participant's performances. However, when there is a significant link between studied participants, such as in the observation study, the two people are engaged in a social interaction, one person's feelings and behaviour will affect another person's behaviour. Therefore, the independence between the participants were violated, hence APIMs are used to explore the interdependence relationship between the participants.

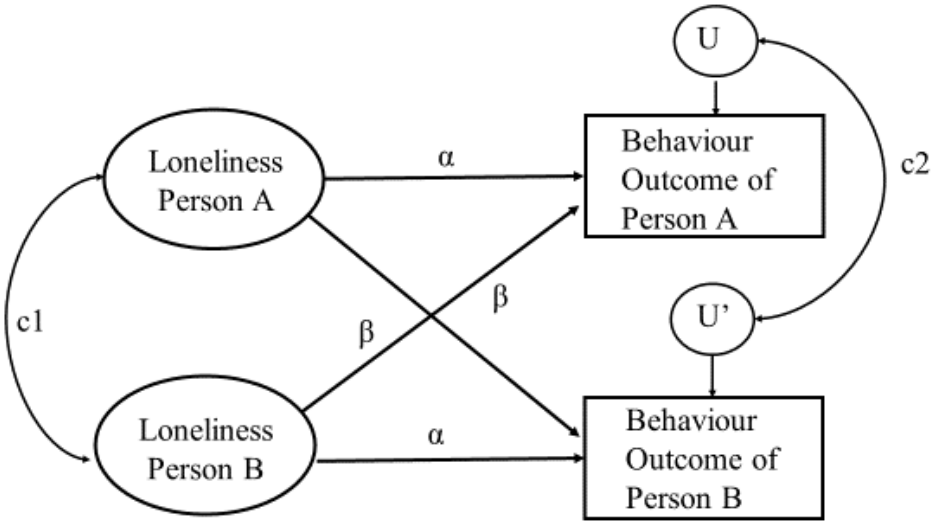
As in a dyadic relationship, it is argued that one person's emotion, cognition or behaviour not only affects their own emotion, cognition or behaviour, but also affects the emotion, cognition, or behaviour of a partner (Cook & Kenny, 2005; Kelley & Thibaut, 1978; Kelley et al., 2003). Therefore, when there is interdependence between the two participants, it is necessary to treat the dyad (or group) rather than the individual as the unit of analysis (Cook & Kenny 2005).

The APIM model has been widely used in the study of families and close relationships, e.g. mother-child, married couples, etc. (Cook & Kenny, 2005). In the current study, interacting female friends are the dyad under study.

Figure 4.1 shows the path diagram of an APIM model in the current study. The two *actor effects (α)* represent the extent of how a person's loneliness level impact her own behaviour. The two *partner effects (β)* represent the extent to which one person's loneliness level impact on their partner's behaviour. The two double arrows, named c1 and c2 in thi s model, represent the correlation between the two independent variables and the two outcomes variables respectively.

The possible effect of loneliness on participants' evaluation of the interaction, friendship functions and all interactive behaviour is tested by analysing the APIM model multiple times, each time with a different outcome variable.

Figure 4.1. The Actor-Partner Interdependence Model of the current study



Note. Single-headed arrows indicate causal or predictive paths. Double-headed arrows indicate correlated variables. Paths labelled as α indicate actor effects and paths labelled as β indicate partner effects. A significant actor effect indicates that loneliness level of one predict certain behaviour of themselves. A significant partner effect indicates that one person's loneliness level predict a behaviour of their partners.

Results

Characteristics of the Study Group

Table 4.3 describes the characteristics of the study group and the distribution of loneliness scores. The mean loneliness in the current study is 33.56 (*SD* = 8.71), which is in line with prior research (for example, Bell & Daly, 1985; Watson & Nesdale, 2012), therefore, the results are comparable with previous research. Moreover, the loneliness score for the individuals in a friendship less than 12 month with their interaction partner (*M* = 33.99, *SD* = 8.68) is slightly higher than individuals who have been in a friendship with their friends for longer than 12 months (*M* = 31.76, *SD* = 8.32). Female university students aged between 30 to 49 scored slightly higher in loneliness (*M* = 35.20, *SD* = 8.24) compared with individuals between the ages 18 to 29 (*M* = 33.76, *SD* = 8.80).

Table 4.3. *Social demographic characteristic and loneliness score in the current study*

(Gender: all females)	Number of Participants	Age	Loneliness Mean	SD
Whole sample	114	21.50(6.15)	33.56	8.71
Friendship length ≤12 Months	74	21.08(6.01)	33.99	8.68
Friendship length >12 Months	35	22.49(6.74)	31.76	8.32
Age (18-29)	103	19.77(2.29)	33.76	8.80
Age (30-49)	10	39.40(4.65)	35.20	8.24

APIM Results for Loneliness and Interaction Behaviour

The results of the actor and partner effects of loneliness on social behaviour between the dyads were shown in Table 4.4. The results showed that a higher level of loneliness in participants was associated with participants gazing less at themselves (β = -.15, p = .036*) and less gaze at their friend's body (β = -.18, p = .012*) during the interaction. A higher level of loneliness also predicted more No Back Channel behaviour (β = .21, p = .002**). The results indicated that participants with higher levels of loneliness scores gave less visual attention to themselves and their partners, but they were inclined to show subtle manipulative behaviour by being less responsive towards their partner.

For partner effects (how one person's loneliness score effect their partner's behaviour), a positive relationship was found between Loneliness and Open-ended Question (β = .16, p = .019*), Sighing (β = .18, p = .008**), No Back Channel (β = -.14, p = .048*) and a negative relationship between loneliness and Looking at their Friend's Face, (β = -.15, p = .028*). These results indicate that friends of people scored a higher level of loneliness score asked more open-ended questions, responded more to their friends, sighed more and gave less visual attention to their friends. The results suggest that friends of the lonely participants appear to be friendly when interacting with lonely female university students, they tried to create a friendly social environment for their friends, but they felt sad and showed less interest in their friends over the course of the interaction.

Taken together, the results indicate that interaction style between female lonely universities students appear to be passive and less rewarding, with lonely females being more passive, whereas friends of lonely females showed more prosocial behaviour but also inclined to feel sad and loss of interest. See results illustration in Figure 4.2.

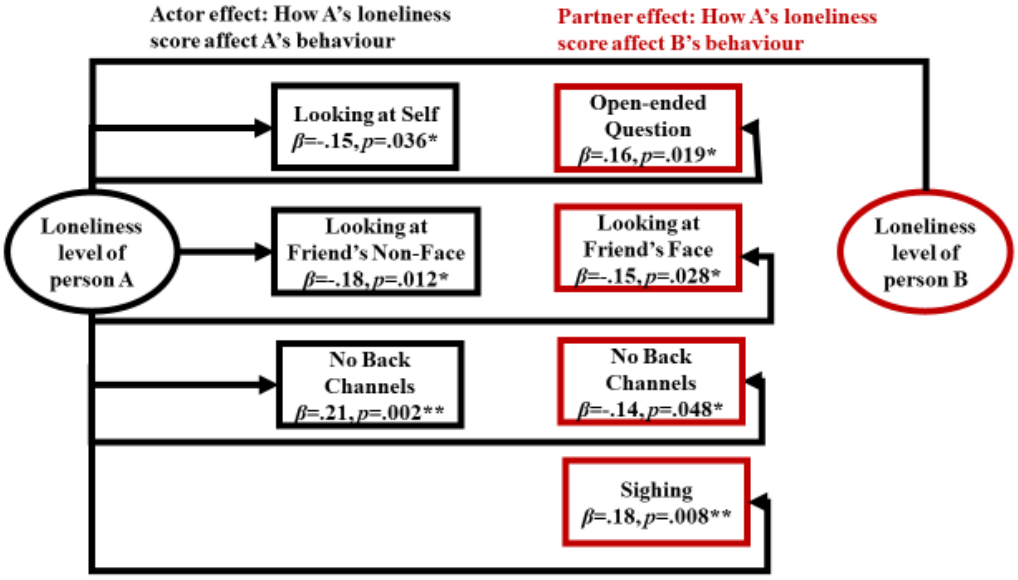
Table 4.4. *Summary of APIM results of loneliness and interactive behaviour*

	Actor β	Sig.	Partner β	Sig.	C2	Sig.
Looking at Self	-.15	.036*	-.004	.955	.05	.582
Looking at Friend's non-face	-.18	.012*	-.03	.628	.15	.130
No Back Channels	.21	.002**	-.14	.048*	.12	.202
Open-Ended Question	.000	.995	.16	.019*	.18	.061
Looking at Friend's Face	-.06	.375	-.15	.028*	.17	.083
Sighing	-.12	.078	.18	.008**	.24	.013*

Notes: c1 = concurrent correlation between person 1's loneliness and person 2's loneliness levels; loneliness is correlated the same for all behaviour, correlation is .40 and significant ($p < .001$); actor = the influence of one's loneliness on their own behaviour; partner = the influence of one's loneliness on their partner's behaviour; c2 = concurrent correlation between one person's behaviour and their partner's behaviour. One hundred and twelve participants provided data in this study.

* indicate results were significant at .05.
** Indicate the results were significant at .01.
*** indicate results were significant at .001.

Figure 4.2 APIMs results illustration of loneliness on selves' and partners' interaction behaviour



Note: Lonely female university students responded less to their friends; whereas friends of lonely female students asked more open-ended questions, and responded more often to their friends, suggest they are friendlier towards lonely individuals.

Results of Loneliness and Post Interaction Questionnaires

Next, to examine the impact of loneliness on one selves' and their friends' perceptions of the interactions and their friendships, loneliness scores, post interaction questionnaire scores and friendship function scores were subjected to an APIM analysis. The results were shown in Table 4.5 and 4.6. The illustration of the results were presented in Figure 4.3 and Figure 4.4.

Post interaction questionnaire 1 (Barry & Hansen, 2000). The questionnaire were distributed to examine how each member of the dyad evaluate the 15-minute social interaction with their friend. Four dimensions of the interaction: Quality, Disclosure, Engagement and Intimacy were assessed by this questionnaire. The results showed that both of the actor and partner effects between loneliness and the quality of the interaction are negative and statistically significant (actor effect: β = -.29, p < .001***, partner effect: β = -.13, p = .031*). These results indicate that a higher level of loneliness scores was associated with both self-rated and partner-rated lower quality of the interaction.

No actor or partner effects were found between loneliness and the other post interaction dimensions: disclosure, engagement and intimacy.

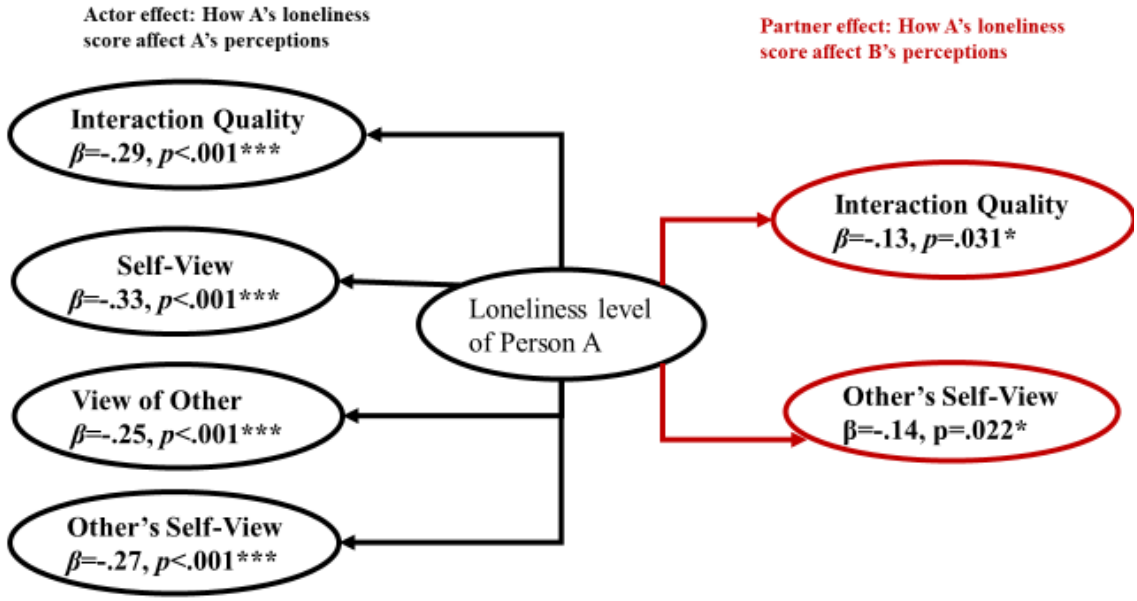
Post interaction questionnaire 2 (Jones et al., 1982). The questionnaire were distributed to examine how the dyads perceived their own and their partner's performances during the interaction. The four questions of this measure: (1) self-view (how people will rate them for the interaction), (2) other's view (how people would rate their partner's performance in this interaction), (3) view of other's (how people thought their partner would rate them, and (4) other's self-view (how the subject thinks their partner would rate herself for the interaction) were subjected to the APIM model individually.

The results showed a significant negative actor effect for loneliness on Self View: β = -.33, p < .001***, View of Other: β = -.25, p < .001*** and Other's Self-view: β = -.27, p < .001***. There were no significant relationship between loneliness scores and Other's View, β = -.03, p = .663. These results show that loneliness yields a significant negative self-ratings and ratings of partner's performance during the observed interaction. Moreover, lonely female university

students also believed that their friends would rate their selves negatively for the interaction.

No partner effect was significant in Self-view, View of Others and Other's View. However, there was a significant partner effect between loneliness and Other's Self-view (β = -.14, p = .026*). The results suggest that friends of those who feel lonely did not rate their own and their partner's performances negatively, but the partners of people who feel lonely captures lonely females' negative outlook on themselves: that they believe their lonely female friends will rate themselves negatively for the performance in the social interaction.

Figure 4.3. The illustration of the APIMS results of the impact of loneliness on self and other's post-interaction questionnaire ratings

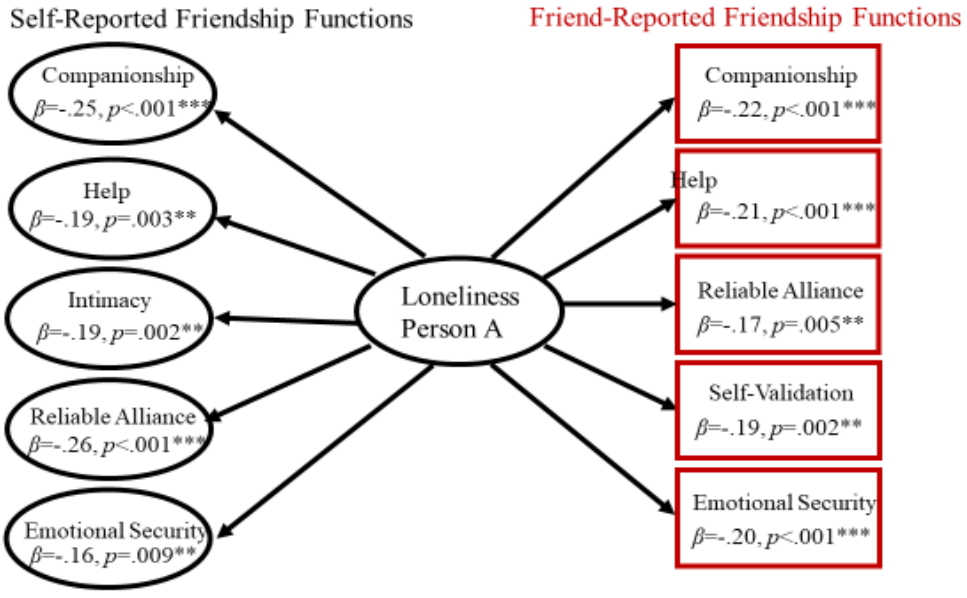


Note: Loneliness is associated with a negative self-rated and partner-rated negative evaluation of the social interaction quality and a more negative perceptions of themselves and others in general. Lonely female university students' negative self-views were captured by their friends.

Friendship function questionnaire. The Friendship Function Questionnaire consists of questions related to 6 aspects of friendship functions: Companionship, Help, Intimacy, Self-validation, Reliable Alliance and Emotional security. Participants rated their partner in terms of how they fulfilled each function. The results were shown in Table 4.5, the graphic illustration of the results were shown in Figure 4.4.

APIMS for these friendship functions showed significant Actor effects for loneliness on Companionship (β = -.25, p < .001***), Help (β = -.19, p = .003**), Intimacy (β = -.19, p = .002**), Reliable Alliance (β = -.26, p < .001***) and Emotional Security (β = -.16, p = .009**). The results suggest that lonely people perceived their friend as less fulfilling of these friendship functions. Moreover, negative partner effects were found for loneliness on Companionship (β = -.22, p < .001***), Help (β = -.21, p < .001***), Reliable Alliance (β = -.17, p = .005**), Self-Validation (β = -.19, p = .002**), and Emotional Security (β = -.20, p < .001***). The results suggest that the loneliness scores of individuals predicted lower partner ratings of all the friendship functions apart from the function of Intimacy.

Figure 4.4 APIMs results of loneliness on self-rated and partner rated friendship functions



Note: Loneliness is negatively associated with both self-perceived and friend-perceived friendship functions.

Table 4.5. *Means, Standard Deviation of Post Interaction Questionnaires and APIM results of Loneliness and Post Interaction Questionnaires*

	Mean	**Standard Deviation**	**Actor Beta**	**Actor p value**	**Partner Beta**	**Partner p value**	**C2 Correlation**	**sig**
Quality	7.00	.94	-.29	.000***	-.13	.031*	.683	.000***
Disclosure	5.77	2.27	-.01	.900	-.04	.568	.519	.000***
Engagement	4.72	1.95	.12	.064	-.04	.510	.398	.000***
Intimacy	4.55	2.15	-.01	.986	-.04	.588	.360	.000***
self-view	7.16	1.66	-.33	.000***	.02	.793	.236	.015*
view of other	7.49	1.52	-.25	.000***	-.03	.624	.383	.000***
other's view	7.42	1.49	-.03	.663	-.02	.745	.377	.000***
other's self-view	7.28	1.57	-.27	.000***	-.14	.022*	.423	.000***

Notes: c1 = concurrent correlation between person 1's loneliness and person 2's loneliness levels; loneliness is correlated the same for all post interaction questions, correlation is .38 and significant ($p < .001$); actor = the influence of one's loneliness on their own rating of the interactions; partner = the influence of one's loneliness on their partner's rating of the interaction; c2 = concurrent correlation between one person's behaviour and their partner's behaviour. One hundred and twelve participants provided data in this study.

* Indicate results were significant at .05.
** Indicate the results were significant at .01.
*** Indicate results were significant at .001.

Table 4.6. *Means and Standard Deviations of Friendship Functions scores and APIM Results of Loneliness and Friendship Functions*

	Mean	**Standard Deviation**	**Actor Beta**	**Actor p value**	**Partner Beta**	**Partner p value**	**C2 Correlation**	**sig**
Companionship	35.56	5.32	-.25	.000***	-.22	.000***	.584	.000***
Help	34.18	6.01	-.19	.003**	-.21	.000***	.391	.000***
Intimacy	34.85	6.41	-.19	.002**	-.07	.292	.598	.000***
Reliable alliance	35.35	5.38	-.26	.000***	-.17	.005**	.480	.000***
Self-validation	33.07	7.33	-.09	.153	-.19	.002***	.505	.000***
Emotional Security	33.96	5.91	-.16	.009**	-.20	.000***	.577	.000***

Notes: c1 = concurrent correlation between person 1's loneliness and person 2's loneliness levels; loneliness is correlated the same for all friendship functions, correlation is .40 and significant ($p < .001$); actor = the influence of one's loneliness on their own rating of friendship functions; partner = the influence of one's loneliness on their partner's rating of friendship functions; c2 = concurrent correlation between one person's behaviour and their partner's behaviour. One hundred and twelve participants provided data in this study.

* Indicate results were significant at .05.
** Indicate the results were significant at .01.
*** Indicate results were significant at .001.

Summary of the APIM Results of Loneliness, Social Behaviour and Post-Interaction Questionnaires

The results of the APIM analyses of loneliness, social behaviour and post-interaction questionnaires showed that females with a higher level of loneliness scores were less responsive towards their partners, the partners showed an elevated level of sadness but also asked more open-ended questions. The results suggest a negative pattern of interaction, with negative behaviour displayed by both parties.

Next, for the ratings of the post-interaction questionnaires, the results showed both parties of the friendship reported a negative interaction quality and a lack of fulfilments of the friendship functions. For the evaluation of self and others' performances of the interaction, females with a higher level of loneliness held a negative outlook in all aspects of the evaluations of self and others of the interaction, the reciprocal negative evaluation were only found in how the partners viewed lonely people: that partners believe lonely females would rate themselves negatively, and rate their friends negatively.

Results of Long and Short Friendship Group

The friendship length was different across participants in this study, ranging from 5 weeks to 216 months. Because friendship lengths are important when considering individuals subjective definition of friendships (Adam, Bliezner & Vries, 2000), and the rating of propinquity and similarity of a friend (Mesch, 2005), the interaction behaviour and perceptions of a friend may be affected in the current study. Therefore, a series of APIM analyses were conducted to examine how loneliness impacted on behaviour and perceptions differently in short and long friendships.

Fifty-six dyads were divided into two groups based on their friendship length. There were two dyads that did not provide their friendship length, so only 54 dyads' results were included in the final analyses reported in this section of the thesis. The long friendship group (17 dyads) included the dyads who been in the friendship over 12 months and the short friendship group included people who been in the friendship for 12 months or less than 12 months (37 dyads). 12 months is the Median and Mode of friendship length in this study, with the Mean of the length of friendship being 28.78 months; therefore, the standard deviation was very large (*SD* = 45.72) and it might not be the best representation of the average of the sample.

Correlation difference between the dyads. Table 4.7 showed the correlation of the loneliness scores between the members of the dyads. For the whole sample, the correlation between the dyads is .40. For the dyad members in the short friendship group (friendship duration less than 12 months), the correlation is .47, whereas for members in a friendship longer than 12 months, the correlation was not significant, $r = .01$, $p = .950$.

Table 4.7. *Correlation between the loneliness scores of the dyads in the whole sample, friendship lasted shorter than 12 months, and over 12 months*

	Correlation	p-value
Whole sample	.40	$p < .001$***
Friendship ≤12 months	.47	$p < .001$***
Friendship >12 months	.01	$p = .950$, n.s.

Results of loneliness and interactive behaviour of the dyads have been in a friendship for less than 12 months, and longer than 12 months. The loneliness level and social behaviour of participants in both groups based on friendship duration were subjected to the APIM analyses. The results were shown in Appendix 11 and Appendix 12.

The results showed that females with a higher level of loneliness produced fewer successful interruptions with friends they have been in a friendship with for less than 12 months, β=-.24, p = .007**, but they produced more successful interruptions when within a friendship for longer than 12 months, β = .27, p = .019*. Friends of the females who feel lonely elicited sadness behavior in both short friendship group (sighing: β = .25, p = .004**) and long friendship group (pouting and sulking: β = .27, p = .022*), suggesting the friends tend to feel sad in the interaction with females with a higher level of loneliness score.

Moreover, females scoring higher on the loneliness scale showed more No Back Channel behavior with people whom they have been in a friendship with for longer than 12 months (β = .39, p < .001**). The No Back Channel behaviour refers to a lack of response towards their friend. It may convey the message of lack of interest and putting up a distant against their friend. Such behaviour was not found in the friendship dyads in a friendship for less than 12 months' time, suggesting that females with a higher level of loneliness only display this type of behaviour with friends who they have known for a longer period of time.

Results of loneliness and questionnaire scores of the dyads have been in a friendship for less than 12 months, and longer than 12 months. Loneliness scores, post interaction questionnaire scores, and friendship function scores were subjected to APIM analyses to examine the impact of loneliness on individual and partner's perception of the interaction and the friendship. The results showed that although individuals with higher loneliness scores rated themselves and the quality of interaction more negatively in both groups, they were perceived differently by the friends in the two groups.

Post-Interaction Quality. The results showed that both female university students with a higher level of loneliness scores and their friends reported a lower interaction quality in their interaction if they have been in the friendship for less than

12 months (actor: β = -.22, p = .002**; partner: β = -.20, p = .006**), but these effects not shown in the friendship group that lasted longer than 12 months.

Friends of the lonely females reported the interaction as lack of intimacy (β = -.22, p = .011*) in the friendships lasted less than 12 month, but friends of lonely females who have been in the friendship for longer than 12 months reported the Interaction as more intimate (β = .28, p = .021*).

Perceptions of Selves and Others. For the perceptions of selves and others, individuals with higher level of loneliness scores reported more negative views of themselves in both friendships with lengths of under 12 months (β = -.29, p < .001***), but not over 12 months. Moreover, lonely females in the friendship lasted less than 12 month reported a negative Other's View (β = -.28, p < .001***) and Other's Self-View (β = -.35, p < .001***), suggesting lonely females in the short friendship group believe their friends will rate others and rate their self negatively, whereas in the long friendship, these effects were not presented. Furthermore, lonely females were viewed more positively by females who have been friendships for longer than 12 months (β = .30, p = .012*) but they were viewed by friends who have known them for less than 12 months as viewing other people more negatively (β = -.16, p = .049*).

Friendship Functions. The friendship functions were rated differently by the two friendship groups based on friendship duration. For the dyads in a friendship for less than 12 months, both high lonely females and their friends reported a lack of fulfilling of various friendship functions (actor effects: Companionship: β =-.19, p =.014*; Reliable Alliance: β =-.22, p =.007**), Emotional Security: β = -.22, p = .007**); (partner effects: Companionship: β =-.22, p =.003**; Help: β =-.19, p = .022*; Self-validation: β =-.23, p =.004**). However, there were no significant actor or partner effects in the friendships over 12 month, suggesting that loneliness might not affect the fulfilment of friendship functions in a relatively long female friendship.

Discussion

The results of the current observational study show that female university students with a higher level of loneliness have negative social interactions with their same-sex friends. Participants with a higher level of loneliness scores were less responsive towards their friends. Friends of females with a higher level of loneliness scores asked more open-ended questions, and responded more to their friend, but showed an elevated disengagement and sadness behaviour during the interaction.

The perceptions of the quality of the interaction, evaluation of their partners, and friendship function are also negative reciprocally, suggesting that females with a higher level of loneliness have a less fulfilling friendships in general. The results also differed based on friendship duration, individuals with a higher level of loneliness scores with friends in the friendship for less than 12 months, perceived the interaction, their friend, and the friendship more negatively compared with those within a friendship over 12 months. On the other hand, individuals with a higher level of loneliness scores showed more negative behaviour with the friends they had had for longer than 12 months, but they were perceived more positively by their partners.

The Impact of Loneliness on Social Behaviour and Social Perceptions

One of the key findings in the current study is that loneliness was related to the behaviour associated with partner interest and subtle manipulation behaviour in social interaction. Many foregoing studies have concluded that loneliness is related to a withdrawn (Qualter et al. 2015) and self-preserving behaviour (Cacioppo et al., 2014). The results of the current study are in line with this argument. Although individuals with a higher level of loneliness did not exhibit behaviour that relates to sadness and passivity, for example, not talking, less laughing, sadness behaviour, their behaviour appeared to convey the message of rather less interest in their partner.

It is also important that females with a higher level of loneliness scores are aware their interactions are negative, because they viewed their own performance negatively and rated the quality of the interaction poorly. The results of the current study show that lonely people had negative perceptions of the quality of interactions, and a negative Self-View, View of Others and Others' Self-view. These results are in

line with many previous research (for example, Duck, et al., 1994; Jones, et al., 1981; Lodder et al., 2015; Van Roekel et al., 2014, 2016; Vitkus & Horowitz, 1987), and confirms that one of the key characteristics of lonely females is that they hold a negative perception of selves, others and their social relationships.

The negative predisposition they adopt in their social interactions, and the behaviour that exhibited in the social interactions, confirms that an individual with a higher level of loneliness scores tend to think and act in a more negative way, and these are being captured by others, and subsequently leading to more negative interactions.

The finding of a higher level of loneliness score also predicts the increase of partner's sadness behaviour, the results reveal that the friends of people with a higher loneliness score did not experience a positive and nourishing social interaction with their friends. Given that lonely individuals elicit more "No Back Channels" behaviour to their partners, it is possible that their friends exhibited more sadness behaviour because they perceive lonely individuals as less supportive and less responsive. Considering the conversation with lonely partners is often negative (Duck, Pond, & Leatham, 1994), the findings of the current study provide empirical data supporting the behavioural profile outlined in previous research, that lonely individuals are passive communicators and attribute less partner attention to their friends (Jones, et al. 1982).

The Impact of Friendship Length

The results showed a difference in behavioural patterns for lonely individuals depending on whether they were interacting with a friend whom they had known for less than 12 months or more than 12 months. The differences were particularly evident in the areas of sadness behaviour and domineering behaviour. Females with a higher level of loneliness scores made more successful interruptions with friends they knew for longer than 12 months but made fewer successful interruptions with friends they knew for under 12 months. Friends of the participants with a higher level of loneliness scores showed more sadness behaviour in both groups during the social interaction.

The results indicate that lonely females lack social efficiency with both new and old friendships. This may be the result of their friends experiencing more sadness during the interaction. Considering individuals with higher levels of loneliness scores are hypersensitive to social rejection (Cacioppo & Hawkley, 2009), and more self-focus and self-absorbed (Jones., et al., 1982), they may spend most of their time focusing on their own inferiority during the interaction, and lack of awareness of their partners' feelings.

The current study also reveals that other's perceptions of lonely individuals are not always negative. The friends' perception of individuals with a higher level of loneliness score varies according to the friendship duration. For individuals who have been in a friendship with high lonely females for less than 12 months, the friends of females with a higher level of loneliness scores reported the interaction as poor quality, and rate lonely females more negatively. On the other hand, friends of individuals with a higher level of loneliness scores in a friendship over 12 months attributed more positive ratings to lonely individuals, suggesting a different type of appraisal criteria by acquaintances and old friends.

This is in line with much research supporting the notion that lonely individuals are characterized by a negative outlook of themselves, but are not perceived negatively by others (for example, Christensen & Kashy, 1998; Jones, Freeman & Goswick, 1981; Jones, Hobbs, & Hockenbury, 1982, Lodder et al., 2015). However, most of the foregoing studies did not distinguish participants by friendship length when examining the perceptions of both members of a friendship. The findings of the current study may provide important insight into why people perceive individuals with a high loneliness score differently.

Furthermore, for friendships that lasted for more than 12 months, lonely individuals' friends rated the interaction with lonely females as more intimate. It is possible that the interaction with a long-lasting friend may be less threatening for lonely people compared with relatively new encounters. Therefore, loneliness may be more detrimental to new contacts and new social relationships and may also deteriorate long lasting friendships slowly.

For friendships that lasted for 12 months and under, individuals who scored higher on loneliness tended to rate their own performance negatively, believed other people would rate them negatively, and also believed other people would give themselves negative self-ratings. Lonely females were also perceived by their friends as rating others negatively. The results of friendship lasted for longer than 12 months showed that, although individuals who scored high in loneliness tended to rate themselves negatively, they were rated more positively by their partner.

The results of the second post interaction questionnaire suggests that lonely females attribute more negative ratings of selves and others after interacted with a friend they have been in a friendship for less than 12 month, but they did not report the same negative ratings after interacted with a friend who they have known for longer than 12 months. Moreover, friends' perceptions of lonely females also differed according to their friendship length, with lonely females being perceived as negative by a relatively new friend, but more positively by an old friend. These results are in line with the findings from a dyadic best friendship study conducted by Lodder, Scholte, Goossen and Verhagen (2015): their results show that lonely adolescents experience perceived low friendship quality, but their best friends did not. It is expected that those who have been best friends of lonely people for some time may be aware of lonely individuals' struggle with interpersonal relationships and they tended to have a negative view of themselves and others. The positive ratings by lonely individuals' friends in longer friendships may be driven by a number of factors. First, lonely individuals perform well and use their social skills when they interact with someone they know for a long time. When they are interacting with someone whom they have only known for a short period of time, lonely individuals may not be able to perform well. Loneliness is associated with social anxiety (Knowles et al., 2015), which may create self-focused attention and lead to failure of social performance. Because anxiety may cause extra attention to be focused on the already learned, automatic social skills, which impeded the actual performances (Knowles et al., 2015). The anxiety may impede lonely individual's social skills when they interact with someone they only know for a short period of time. Second, lonely individuals' friends who have known them for a long time may be more likely to understand and support them. Luhmann, Bohn, Holtmann, Koch

and Eid (2016) suggest that informants' ratings of a target differ according to the information one can use about the target. The longer someone knows a person, the more information they will have about that person (Luhmann et al., 2016). Therefore, people who have known lonely individuals for longer may rate them more positively.

The results of the friendship function questionnaire indicate that lonely individuals and their friends tended to perceive each other as less fulfilling of friendship functions. However, feeling lonely does not affect one's own and their friends' perception of fulfilling the functions of friendships in a long friendship. The results indicate that, while lonely individuals may struggle to develop closer friendships, once they are in a long friendship they benefit by gaining the sense of belonging and fulfil their social needs.

Previous research also suggests that lonely adolescents with a higher level of loneliness scores tend to be more negatively affected by a negative company, but more positively affected by a positive company (van Roekel, Goossens, Verhagen, Wouters, Scholte, 2013). The findings of the current study support that notion. It is possible that lonely females' long-lasting friends may be more likely to be of positive company to lonely individuals, given that they tended to view lonely people positively.

Who Are Friends with Lonely People?

There was a significant difference in the correlation between loneliness scores of members in the dyad for the long and short friendship groups. The members of the dyads in the short friendship group tended to be moderately similar in their loneliness scores, whereas in the long friendship group, individual's loneliness scores between the dyads were not correlated. Given that lonely individuals tended to be passive and non-responsive in both long and short friendship groups, but were only perceived negatively by their relatively new friends but were perceived positively by their long-lasting friends, the findings may indicate that lonely people may choose to become friends with another lonely person at the beginning stage of friendship formation, but they may be more likely to develop a long and nourishing friendship with someone who is not lonely.

This finding is in line with the homophily principle in social networks (McPherson, Smith-Lovin & Cook, 2001), which proposes that individuals tend to connect with those who are similar to them. A study conducted by Cacioppo and colleagues (2009) found that lonely people tend to become friends with those who are also lonely. Specifically, a person is 52% more likely to be lonely if another person he/she is directly connected with is lonely (Cacioppo et al., 2009). Findings from child studies also support that idea (Qualter & Munn, 2005).

Therefore, lonely individuals may be attracted to form friendships with other lonely individuals at the beginning of social encounters. However, the results of the current study show that the interactions and the perceptions of friendships in the short friendship group are relatively negative. In the short friendship group, both members of the dyads reported feeling a greater level of negativity in the post interaction quality, perception of self and others, and rated their friends as less fulfilling of friendship function. Hence, it is possible that lonely females may engage with other lonely females when they go to university, but those friendships are inefficient and of relatively poor quality. As a result, lonely individuals may experience further social rejection and become lonelier unless they are able to find a more fulfilling friendship, which we might hypothesise should be with a non-lonely peer.

Although the findings in the current study are significant, there were fewer participants recruited in the long friendship group. Therefore, future research should examine whether the findings of the long friendship group can be replicated and if so, whether there is a significant correlation in loneliness scores between members of friendship dyads. Because loneliness has a social stigma and those who are lonely are less liked by others as a potential friend (Rotenberg & Kmill, 1992), it would be worth researching what motivates people to maintain friendships with lonely individuals in the long term.

Strength and Limitations

The most important strength of the current study is the use of direct observation of individuals' behaviour as long as self-reported questionnaires for individual differences and perception of friendships. That provides objective and subjective measurements that have not been used together in many previous studies. Most of the previous studies examining the social relationships of lonely people used self-reported questionnaires that only measure individuals' loneliness level and perceptions of others without actual behavioural data. That causes problems with subjectivity and may not provide an accurate picture of lonely individuals' social behaviour.

While using direct observation method is an obvious strength to the current study, there are some limitations that need to be addressed in future work. First, the nature of the study is a social task and participants in the current study were recruited on a voluntary basis. Therefore, the sample in the current study may be a relatively less lonely sample. Since loneliness is associated with a lack of involvement in a social network and lack of an intimate dyadic friendship (Hoza, Bukowski & Beery, 2000), it is possible that individuals with a higher level of loneliness may not choose to take part in a study that involves social interaction with friends. However, the mean levels of the baseline loneliness in the current study are comparable with other study samples, which suggests that there is no problem with the sample selection.

Second, some research has found gender differences in the perceivers and target persons of lonely people. For example, Lau and Gruen (1992) argued that lonely males were perceived more negatively compared with lonely females. Moreover, females tended to view lonely people more negatively compared with

males (Lau & Gruen, 1992; Rotenberg & Kmill, 1992). Borys and Perlman (1985) suggested that males may be less socially sensitive compared with women conventionally, therefore they may be less aware of other people's loneliness and are less likely to reject a lonely person. Therefore, future studies should examine whether the behavioural and perceptive differences also occur in male friendship dyads and cross-gender friendship dyads.

Third, another limitation may be that the current study did not examine how lonely people behave and perceive group interaction. According to Hoza et al. (2000), missing a peer group relationship and absence of a close dyadic friendship is associated with different types of loneliness. Therefore, loneliness in peer group interaction should be studied in future interaction.

Fourth, the current study investigated social interactions at one time-point, not across different time frames. The ratings of individual's loneliness levels may only represent a state level of loneliness and may be subject to change in the future. Moreover, for individuals who interacted with a friend who they have known for less than 12 months, their friendship may still be at a beginning stage. Thus, their social behaviour and perceptions are likely to change as these friendships develop. For individuals who are in the long friendship group, it may be important to explore whether the social behaviour of both members of the dyads are consistent across time. Moreover, in the current study, it is not possible to distinguish between individuals who are chronically lonely or temporarily lonely. State loneliness is clinically different from chronic loneliness (Heinrich & Gullone, 2006), thus, individuals in each of the two categories may behave and perceive differently in a friendship. Therefore, future studies should explore friendship progression in a longer time frame and use multiple waves of data collection to examine the behaviour and social perception of those who have high levels of loneliness.

Chapter 5: The Impact of Depressive Symptoms and Social Anxiety on the Study Results

Introduction

As discussed in the literature review, depressive symptoms and social anxiety are important correlates of loneliness. Depression is characterised by emotional dysregulation and sustained negative affect (Gotlib & Joormann, 2010) while social anxiety is characterised by an excessive fear of social situations or negative evaluations from others (American Psychiatric Association, 2013). And, both are correlated with loneliness among adult samples, with depressive symptoms correlated with loneliness in the range between .40 to .60 (Heinrich & Gullone, 2006), social anxiety correlated with loneliness around .48 (Anderson & Harvey, 1988). Despite those correlations, not many studies have controlled for the impact of depressive symptoms and social anxiety while conducting loneliness research. That means that it is not clear whether the effects of loneliness on outcome is the result of shared variance with those other constructs.

A handful of research studies have controlled for the impact of depressive symptoms and social anxiety alongside loneliness. However, they have showed different patterns of results for when they were controlled and when they are not; these works shows it is important to examine how controlling depressive symptoms and social anxiety affects the relationships between loneliness and outcome. For example, an emotional recognition study conducted by Vanhalst, Gibb, and Prinstein (2015) showed that after controlling for depressive symptoms and social anxiety, the effect of loneliness in recognising sad and fear faces became stronger (Sad faces: from β=-.16* to -.28*; Fear faces: from β=-.19* to -.35**) and the effect of loneliness in recognising happy faces disappeared (from r=-.20* to r=.12). Other research, in contrast, has found no differences in the results of loneliness after controlling for depressive symptoms. Lodder et al., (2015) controlled for the association between depressive symptoms and social anxiety with loneliness when investigating the eye movements when gazing at image-based emotional faces and found no significant effects of loneliness on visual attention on social cues in adolescents. Moreover, a study of lonely college students' eye gaze pattern in social interaction was conducted by Lodder, Scholte, et al., (2015), they found a significant

effect of loneliness on the increased gaze duration on partner's face, but the model fit of the Actor-Partner Interdependence Model did not improve after controlling for the impact of depressive symptoms and social anxiety.

To summarise, studies examined loneliness on cognitive processes and behavioural outcomes with and without controlling for depressive symptoms and social anxiety yielded different results. Therefore, with the aim of providing a clearer picture that disentangles the effect of depressive symptoms and social anxiety on the influence of loneliness, the current study will control the effects of depressive symptoms and social anxiety on loneliness when studying the cognitive biases and social behaviour of lonely individuals. Because depressive symptoms and social anxiety are associated with a series of cognitive biases and behavioural features that overlap with loneliness, the next section will summarise these associations.

Cognitive Biases and Social Behavioural Pattern in Relation to Depressive Symptoms and Social Anxiety

Depressive symptoms and social anxiety, are not only correlating with loneliness, but they also share overlapping cognitive biases and behavioural manifestations with loneliness. For example, depressive symptoms are associated with a heightened memory for negative information compared with non-depressive symptoms (MacLeod, 2005). In a meta-analysis of memory bias in depressed and non-depressed individuals, individuals with major depression remembered 10% of negative words than positive words while non-depressed individuals, however, remembered more positive words than negative words in 20 out of 25 studies (Matt, Vazquez & Campbell, 1992). Likewise, social anxiety shares the important cognitive features "hypervigilance to social threat" with loneliness (Lim et al., 2016). According to empirical reviews, socially anxious individuals tend to selectively attend to negative social information, which leads to a bias in interpretation and recollection of social events (Mellings & Alden, 2000).

Moreover, in the behavioural and social perceptions domain, depression is known to be associated with social withdrawal, negative self-appraisal, and self-perceived social failure (Kupferberg, Bicks & Hasler, 2016). Those characteristics are also found in lonely individuals (Young, 1982). Social anxiety is characterised by

anxiety-related behaviours in social interaction, such as poor eye contact, short talk duration, pauses in conversation, low level self-disclosure, trembling, blushing and other anxious behaviour (for a review, see Alden & Taylor, 2004). The passive interaction behaviour is also exhibited in lonely individuals. Studies of loneliness and social behaviour have established that lonely individuals tend to acted in a socially withdrawn fashion in social situations (Ernst & Cacioppo, 1999). High lonely individuals showed poorer social skills and gave less attention to their partners in social interactions (Jones et al., 1982), they often talked less, interrupted less, and provided less response to their friends (Bell, 1985).

The details of attentional and memory bias, social behaviour and perceptions in depressive symptoms and social anxiety is introduced in the next section.

Depressive Symptoms and Cognitive Biases

Attentional biases in depression. Williams et al. (1997) suggest that depressed individuals do not direct their attention to negative information in early, automatic information processing. However, once negative information captures their attention, they exhibit difficulties in disengaging from that stimuli (Gotlib & Joormann, 2010). Studies that used eye tracking technology provide evidence for this argument. For example, Caseras et al. (2007) used eye tracking and found that depressed individuals do not show more shifts of their attention towards negative stimuli than controlled individuals. However, once their attention is captured by the negative stimuli, they spend significantly more time looking at these stimuli. Lonely young adults, on the opposite, show an initial focus on the negative stimuli but quickly disengage from the social threat scene after initial viewing (Bangee et al., 2014). However, studies of the visual attention in lonely individuals often controlled for the impact of depressive symptoms and social anxiety (for example, Bangee et al., 2014; Lodder et al., 2015). Therefore, it is important to compare the findings with and without controlling the association between loneliness and depression on attentional biases studies, and provide insights on this matter for future research.

Memory biases in depression. There is strong evidence showing that memory bias exists in depressive individuals, and primarily in explicit memory (Mathews & MacLeod, 2005). Explicit memory refers to situations in which participants are asked to recall or recognise information that has been presented to

them, for example, a free recall task or a recognition task (Hirsch & Clark, 2004). Depressed individuals tend to recall more negative information than positive information (Mathews & MacLeod, 2005, Matt, Vazquez & Campbell, et al., 1992), whilst non-depressed individuals tend to remember more positive information (for a review, see Gotlib & Joormann, 2010). So far, studies examining loneliness and memory are limited. In one of the few studies that has explored the potential relationship between loneliness and memory, Gardner et al. (2005) found that lonely individuals show an increased recall of both social threat information and social positive information. However, no differences in recall of social threat and social positive information have been found in children (Harris, 2014). Although more research needs to be conducted to examine the memory of social information in lonely individuals, it is likely that memory biases towards negative information may be exhibited in both lonely and depressed individuals. Therefore, it is important to control for depressive symptoms when examining the memory biases in lonely individuals**.**

Social Anxiety and Cognitive Biases

Attentional biases in social anxiety. Attentional bias in social anxiety is primarily associated with the processing of socially threatening information. Selective attention to social threat cues has been found in both clinical and non-clinical population of social anxiety (Buckner, Maner & Schemidt, 2010). Attentional bias in social anxiety exists in various forms. Fistikci et al. (2015) describe the three most common forms of attentional bias associated with socially anxious individuals. Individuals exhibiting attentional bias tend to (1) direct their attention toward the social threat/ be hypervigilant to social threat (2) show difficulties in disengaging from the socially threatening stimuli, and/or (3) show avoidance of paying attention to social threat (Fistikci et al., 2015, Buckner et al., 2010).

All three forms of attentional biases noted above towards social threat have been found in the research examining attentional biases in relation to loneliness (for example, Bangee et al, 2014, Cacioppo et al, 2015, Qualter et al, 2013). The relationships between anxiety and loneliness have been outlined in many studies. Some studies have found anxiety and loneliness can be independent of one another.

For example, Solano and Koester (1989) argue that anxiety has an impact on loneliness independently, as individuals tend to experience loneliness when they suffer from high social anxiety and low social skills or low social anxiety and low skills, which indicate that loneliness can co-occur with or without social anxiety. Therefore, individuals who are lonely may or may not show different forms of attentional biases because of social anxiety. More research is clearly required so that the overlap of attentional biases to threat in both loneliness and social anxiety can be disentangled. Therefore, it is important to control for social anxiety when examining attentional biases in lonely individuals.

Memory biases in social anxiety. Hirsch and Clark (2004) suggest that the explicit memory bias for social threat information is not salient in socially anxious individuals. However, explicit memory bias for words may occur under certain conditions. Hirsch and Clark (2004) argue that socially anxious individuals tend to show an explicit memory bias towards social threat information when anticipating social threat, i.e. participants in their study were told that they were required to give a public speech and the speech would be filmed and rated before attempting recall of words (for example, Mansell & Clark, 1999). A study conducted by Knowles et al. (2015) argued that anxiety plays an important role in loneliness. Lonely individuals tended to choke under social pressure, which occurs when individuals perform worse than they are capable of when they expected to perform well in a situation (Baumeister, 1984), because worry about failing may create anxiety that deteriorate working memory and close attentional control (Beilock & Carr, 2005). As the memory bias associated with loneliness has not been widely explored, it is important to control for social anxiety in the current study to identify any potential differences in memory bias associated specifically with loneliness and/or social anxiety.

Depressive Symptoms in Relation to Social Behaviour and Social Perceptions

Depression is known to be associated with social withdrawal, negative self-appraisal and self-perceived social failure (Kupferberg, Bicks & Hasler, 2016). These characteristics are also found in lonely individuals (Young, 1982). Moreover, people tend to exhibit negative interaction when responding to depressed people (Sacco & Vaughan, 2006). However, despite the common characteristics shared by depressive symptoms and loneliness in the social domain, loneliness is found to be

related to more generalised friendship problems, but the same was not observed for depressive symptoms (Spithoven, et al. 2016).

In a recent cluster analysis, Spithoven and colleagues (2016) argue that loneliness can co-occur or occur independently with depressive symptoms (people can score high on both constructs and people can score highly on one scale and low on the other scale). People belonging to each cluster have different friendship qualities. For example, adolescents who are either just lonely, or lonely and depressed tend to have a lower quality of friendship than individuals who score only high on depressive symptoms. These results indicate that it is loneliness rather than depressive symptoms that has a greater impact on friendship quality.

So far, few studies have been carried out to examine the impact of both loneliness and depressive symptoms on behaviour and perception. Because depressive symptoms and loneliness are inter-related, depressive symptoms may have a significant impact on loneliness in relation to attributional styles and social interactions. Therefore, it is important to consider the impact of loneliness in social relationships while controlling any influence of depression on the social interaction or on loneliness. In the current study, the results of interactive behaviour and post-interaction evaluation are subjected to analyses with 1) loneliness scores, and 2) the loneliness scores after controlling for depressive symptoms.

Social Anxiety in Relation to Social Behaviour and Social Perceptions

There is a body of work (see Heerey & Kring, 2007) that shows how social anxiety is related to many domains of interaction behaviour. For example, socially anxious individuals exhibit high levels of fidgeting, poor reciprocity in smiling, high levels of self-talk, and frequent assurance seeking. Those behaviour has also been found in research examining the social behaviour of lonely individuals as loneliness is related to social anxiety (Jones et al., 1981). Moreover, research using social skills training as an intervention for loneliness (for example, partner attention training) has been evidenced to be successful, likely because it reduces anxiety surrounding social engagement (Jones, Hobbs, Hockenbury, 1982). However, the effect of social anxiety on social skills and loneliness has been overlooked in the research generally despite the fact that loneliness and social anxiety share negative affect. Both loneliness and social anxiety are also related to social skill deficits and self-focused

attention. For example, Leary (1983) argues that when considering communication, there is a separation of actual social skills deficits and anxiety about skill deficits. Loneliness is linked to both social skill deficits and perceived social skill deficits. It is possible that social anxiety mediates both of these relationships.

Research has also examined the relationships between loneliness, actual social skills, and perceived social skills that proposes another relationship between loneliness and social anxiety. Solano and Koester (1989) found that social skill deficits and social anxiety predict loneliness independently, and not interact with one another. That study suggests that individuals are most lonely when they have high communication anxiety and low social skills. However, individuals who have a greater level of anxiety but high levels of skills are lonelier than individuals who have low anxiety and low skills. Individuals with low anxiety and high social skills are the least lonely group.

Because of the overlapping effect of loneliness and social anxiety on social behaviour and social perception, the current study includes analyses for loneliness scores and loneliness scores after controlling for depressive symptoms and social anxiety. Such analyses can separate the effects of social anxiety (and depressive symptoms) from loneliness on interpersonal interactions, and provide new insights for the subject.

Summary of the Relationship between Loneliness, Depression and Social Anxiety

Depression and social anxiety are not only important correlates of loneliness, they also share many common cognitive and behavioural features with loneliness. However, so far, there are no clear rules for whether it is necessary to control for those variables when conducting loneliness research in relation to cognitive biases and social behaviour. Therefore, in the current thesis, the results of controlling for the covariates were compared with the results without controlling for the covariates to disentangle this relationship.

The results of both studies in the current thesis (cognitive study and observation study) will be reanalysed, with the loneliness score controlled by depressive symptoms and social anxiety. The two sets of the results will be

compared thoroughly, and the necessity to control for these covariates will be discussed.

Hypothesis

Because depressive symptoms and social anxiety share important cognitive and behavioural features with loneliness, the following were hypothesized:

1. Depressive symptoms and social anxiety will impact on the relationships between loneliness and attentional biases and memory biases
2. Depressive symptoms and social anxiety will impact the effect of loneliness on social behaviour and social perceptions

Method

Participants

Cognitive study. At Time 1, 77 students at the University of Central Lancashire and Cardiff Metropolitan University (63 females) participated in return for £5 Amazon voucher and 6 course credits each. All were native English speakers and reported normal or corrected-to-normal vision and normal hearing. Participants were aged between 18 and 54 years old (*M* = 22.26, *SD* = 7.13). The same participants took part in all three tasks.

At Time 2, with 10 months apart from the first time point, 23 students (19 females) of the original 77 participants took part in the study. The age range was from 19 to 49, *(M* = 24.22, *SD* = 7.67).

Observation study. 58 female friend dyads (116 women) who attended the University of Central Lancashire participated in the study. The mean age of the participants was *21.52 years (SD = 6.18;* age range was 18 to 49). Participants were recruited via flyers and campus-wide e-mail announcements. Interested female individuals signed up with one of their female friends for this study in exchange for course credits (6 SONA points) and a £5 Amazon voucher.

Materials

Revised UCLA loneliness scale (Russell et al., 1980). The UCLA Loneliness scale comprises 20-items for which participants were instructed to rate how often of each statement was a description of them. Each item scale measured "one's subjective feelings of loneliness as well as feelings of social isolation." Responses were ratings on a Likert scale from 1 (Never) to 4 (Often). The score range of the questionnaire is 20 to 80. Higher scores indicate a higher level of loneliness. Example items include "No one really knows me well", "I feel left out", and "I am unhappy being so withdrawn". Cronbach's alpha for the scale in the current study was 0.94.

Centre for epidemiologic studies depression scale (CES-D, Radloff, 1977). The CES-D scale is a 20-item scale designed to measure depressive symptomatology in the general population (Radloff, 1977). Participants were

expected to score each item based on how often they felt that way during the past week. Each item was rated on a Likert scale range from 0 (Rarely or none of the time [less than 1 day] to 3 (Most or all of the time [5-7 days])). The range of scores for the questionnaire is 0 to 60. Higher scores suggest the presence of more depressive symptoms. Example items in this scale include: “I was bothered by things that usually don’t bother me”, “I felt that I could not shake off the blues even with help from my family or friends”. Cronbach’s alpha was 0.89 in the current study.

Brief fear of negative evaluation (Leary, 1983). The Brief Fear of Negative Evaluation is a 12-item scale that assesses the degree to which people are apprehensive about being evaluated negatively. Instructions of the scale asked subjects to indicate how characteristic of each statement describes them. Participants responded to each item using a 5-point Likert scale from 1 (Not at all characteristic of me) to 5 (Extremely characteristic of me). The score range for the questionnaire is 12 to 60. Higher scores on the scale indicate a higher tendency to be apprehensive at the prospect of being evaluated negatively (Leary, 1983). Example items in the scale include “I worry about what other people will think of me even when I know it doesn’t make any difference”, “I am afraid that others will not approve of me”. Cronbach’s alpha was 0.92 in the current study.

Interaction anxiousness scale (Leary, 1983). The Interaction Anxiousness Scale measures the general tendencies of participants to experience anxious feelings in situations involving contingent social interactions (Leary, 1983). The Interaction Anxiousness Scale consists of 15 items, each item was measured on a 5-point Likert scale from 1 (Not at all characteristic of me) to 5 (Extremely characteristic of me). The score range of the scale is 15 to 75. Higher scores on the Interaction Anxiousness Scale indicate a higher level of social anxiety. Example items include “I often feel nervous even in casual get-togethers”, “I wish I had more confidence in social situations”, “I get nervous when I must talk to a teacher or boss”. Cronbach’s alpha was 0.86 in the current study.

Procedure

Brief summary of the procedures of the cognitive study. The cognitive study examined the impact of threat related materials at all stages of cognitive processing in lonely individuals, including (1) the early stages of processing -

selective attention and automatization attention process (i.e. Emotional Stroop task), (2) attentional control, inhibition of attentional capture via the content of irrelevant sound in the context of a short-term memory task (i.e. Serial Recall task) and (3) later processes such as encoding, retrieval and inhibition (i.e. Directed Forgetting task). All tasks included words containing emotional valence as a source of threat. Each experiment used neutral, social threat, social positive, physical threat and physical positive words as stimuli to assess participants' attention and memory processes. The cognitive study the study procedure were detailed in Chapter 3: Cognitive Study, page 120.

Brief summary of the procedure of the observation study. The current thesis carried out an observation study to examine the social interaction and perceptions of high lonely individuals. Female university students were invited to complete a 15-minute interaction and rated their perceptions of the interaction, and perceived friendship quality afterwards. 7 behavioural categories were coded by the researcher, including Eye Contact, Talking, Fear and Tension, Sadness, Domineering, Stonewalling and Interest behaviour. The post-interaction questionnaires were used to measure the dyads' perceptions of the quality of the interaction, perceptions of themselves and their friends' performance during the interaction, and the ratings of how much friendship functions did their partner fulfilled in their friendship. The more details of the study procedure are shown in Chapter 4: Observation Study, Page 228. The data were analysed by the Actor Partner Interdependence Model in SPSS Amos 23. The details of the data analyses plan were shown in page 241.

Results

Sample Diversities of the Cognitive Study

Mean and standard deviations for loneliness, depressive symptoms and social anxiety at Time 1. The mean, standard deviation and the range for the measures are shown in Table 5.1. The mean UCLA loneliness score of the current study sample is comparable to most of the previous research using a university student sample (for example, Anderson et al., 1994; Christensen & Kashy, 1998; Vendeputte et al., 1999; Watson & Nesdale, 2012).

Table 5.1. *Mean and standard Deviations for Loneliness, Depressive Symptoms and Social Anxiety in the cognitive study*

	Mean	SD	Range
Loneliness(UCLA)	39.89	9.95	21-66
Depressive Symptoms (CES-D)	16.62	9.64	0-49
Fear of Negative Evaluation	37.89	12.28	14-60
Interaction Anxiousness	44.66	11.38	22-71

Note. *N*=74

Correlations between the measures at Time 1. Table 5.2 shows the correlations between loneliness, depressive symptoms, fear of negative evaluations and interaction anxiousness. Loneliness is positively correlated with depressive symptoms, fear of negative evaluation, and interaction anxiousness. Loneliness is moderately correlated with depressive symptoms, fear of negative evaluation and interaction anxiousness.

Table 5.2. *Correlation between loneliness, depressive symptoms and social anxiety in the cognitive study at Time 1*

	1	2	3	4
1. Loneliness	-------	.55***	.31**	.50***
2. Depressive Symptoms		-------	.24*	.43***
3. Fear of Negative Evaluation			--------	.61***
4. Interaction Anxiousness				--------

Note. ***p<.001; **p<.01; *p<.05

Controlled loneliness scores at Time 1. A linear regression was run to obtain the loneliness score residuals after controlling for the impact of both depressive symptoms and social anxiety. The results showed that depressive symptoms (β = .42, p < .001***) and interaction anxiousness (β = .31, p = .017*) were both significant predictors of participants' loneliness level, $F(3,73) = 14.80$, p < .001***. Depressive symptoms and social anxiety together accounted for 36.2% of the explained variability of loneliness scores. However, fear of negative evaluation did not predict loneliness in the current study (β = .02, p = .898). Therefore, the residual of loneliness was created by regressing depressive symptoms and interaction anxiousness to loneliness.

Mean and standard deviations for loneliness, depressive symptoms and social anxiety in the cognitive study at Time 2. The means, standard deviations, and the ranges for the measures are shown in Table 5.3. The mean UCLA loneliness score of the current study sample is in line with the data in Time 1, suggesting the samples are comparable even with only 23 participants.

Table 5.3. *Means and standard Deviations for Loneliness, Depressive Symptoms and Social Anxiety in the cognitive study at Time 2*

	Mean	SD	Range
Loneliness(UCLA)	38.43	10.30	25-62
Depressive Symptoms (CES-D)	15.83	12.44	1-48
Fear of Negative Evaluation	40.70	11.14	23-60
Interaction Anxiousness	43.39	10.28	29-68

Note. *N*=23

Correlations between measures at Time2. Table 5.4 shows the correlation between loneliness, depressive symptoms, fear of negative evaluations and interaction anxiousness. Loneliness is positively correlated with depressive symptoms, fear of negative evaluation, and interaction anxiousness.

Table 5.4. *Correlation between loneliness, depressive symptoms and social anxiety in the cognitive study at Time 2*

	1	2	3	4
1. Loneliness	-------	.54**	.63**	.50**
2. Depressive Symptoms		-------	.57**	.42*
3. Fear of Negative Evaluation			--------	.71***
4. Interaction Anxiousness				--------

Note. ***p<.001; **p<.01; *p<.05

Controlled loneliness scores at Time 2. A linear regression was run to obtain the loneliness score residuals after controlling for the impact of both depressive symptoms and social anxiety. The results showed that none of the covariates are significant predictors of loneliness at Time 2 (depressive symptoms (β

= .27, p = .206); fear of negative evaluation (β = .41, p = .142) and interaction anxiousness (β = .09, p = .711), $F(3, 22) = 5.20$, p = .009**. Although the results are not significant, the data were based on only 23 people from the original 77 sample. Therefore, in consistent with the results in Time 1, the loneliness residuals were calculated by regressing depressive symptoms and interaction anxiousness to loneliness.

Sample Diversities of the Observations Study

Table 5.5 shows the mean and standard deviation of questionnaire scores of loneliness, depressive symptoms and Brief fear of negative evaluation. The mean loneliness score in the current study is 33.56 (*SD*=8.71), which is also comparable, but slightly lower to previous research findings (Bell & Daly, 1985; Jones et al., 1981; Hawkley et al., 2003; Rotenberg & Kmill, 1992). The reason may be individuals who feel severely lonely (for example, scoring over 60 based on the UCLA questionnaire (which is defined by Russel, 1982 as "clinical lonely") may be less likely to choose to take part in a study regarding social interaction with their friends. The mean and SD for depressive symptoms and social anxiety in the current study were displayed in Table 5.5.

Table 5.5. *The mean and standard deviation of questionnaire scores of loneliness, depressive symptoms and Brief fear of negative evaluation*

	Mean	SD	Range
Loneliness(UCLA)	33.56	8.71	20-59
Depressive Symptoms (CES-D)	14.15	9.82	0-44
Fear of Negative Evaluation	34.46	11.04	12-60

Note. N=110

The correlation between loneliness, depressive symptoms, and fear of negative evaluation are shown in Table 5.6 below. Loneliness is positively correlated with depressive symptoms and fear of negative evaluation in the current study.

Table 5.6. *Correlation between loneliness, depressive symptoms and social anxiety in the observation study*

	1	2	3
1. Loneliness	-------	.59***	.37**
2. Depressive Symptoms		-------	.31**
3. Fear of Negative Evaluation			--------

Note. ***p<.001; **p<.01; *p<.05

Controlled loneliness score. A linear regression was run to obtain the loneliness score residuals after controlling for the impact of both depressive symptoms and social anxiety. The results showed that depressive symptoms (β = .53, p < .01**) and social anxiety (β = .21, p = .010*) were both significant predictors of participants' loneliness level, $F(2,109) = 33.82$, p<.001***. Depressive symptoms and social anxiety together accounted for 37.6% of the explained variability of loneliness scores.

Cognitive Study Results

Linear and curvilinear regression analyses were run with residual of loneliness as the independent variable, and the performances on all three cognitive tasks (Serial Recall, emotional Stroop, and Directed Forgetting) as dependent variables, to examine the impact of loneliness, without co-occurring with depressive symptoms and social anxiety, on the cognitive task performances.

Serial Recall results at Time 1. To examine the impact of depressive symptoms and social anxiety on the influence of loneliness on the Serial Recall, a series of linear and curvilinear regression analyses were undertaken. The regressions were run with the proportions of correct recall of items in each sound condition as the dependent variables, and loneliness residual as independent variable. The results are shown in Table 5.7.

The results showed that controlling the effects of depressive symptoms and social anxiety on loneliness did not alter the effects of loneliness during Serial Recall performance under the Silent, Neutral, Social Positive and Physical Positive conditions. However, depressive symptoms and social anxiety weakened the effect loneliness had on the serial recall when the background sound was Social Threat or Physical Threat. Before controlling for depressive symptoms and social anxiety, loneliness associated with a trend of better Serial Recall performance in the Social Threat condition (Loneliness: p = .073, Loneliness^2: p = .080, both one-tailed). However, after controlling for depressive symptoms and social anxiety, that trend disappeared, the p-value of the proportion of correct recall for the social threat condition changed from .073 to .718, and .080 to .650. Similarly, for the physical threat condition, the effect of loneliness on better Serial Recall performance for the physical threat condition approached significance (Loneliness: p = .095, Loneliness^2: p = .095, both one-tailed) before controlling for the covariates; that effect disappeared after controlling for the covariates (Loneliness: p=.487, Loneliness^2: p=.560).

Table 5.7. *Curvilinear regression results of loneliness and loneliness residuals as independent variables, proportion of correctly recalled digits for the social threat and physical threat condition in the serial recall task at Time 1 as dependent variables.*

	Loneliness Results		**Loneliness residuals results**	
	β	Sig.	**β**	**Sig.**
Social Threat				
Loneliness	-1.57	.073*	**.04**	**.718**
Loneliness^2	1.53	.080*	**.06**	**.650**
Physical Threat				
Loneliness	-1.46	.095*	**.09**	**.487**
Loneliness^2	1.46	.095*	**.07**	**.560**

Note. N=74

Serial Recall results at Time 2. The regressions were run with the proportions of correct recall of items in each sound condition as dependent variables, and the loneliness residual as the independent variable at Time 2. The results are shown in Table 5.8 below. These showed that after controlling for depressive symptoms and social anxiety, the results were altered to a greater degree compared with the results at Time 1. For example, the p-value increased from .029 to .062 after controlling for depressive symptoms and social anxiety on loneliness, for proportion of correct recall for the silent condition, suggesting that depressive symptoms and social anxiety made encoding of digits poorer. Moreover, the curvilinear trend for the proportion of correct recall of digits for the social threat condition was approaching significance (β = 2.95, p = .080, one-tailed) before controlling for the covariates, but that effect became non-significant after controlling for depressive symptoms and social anxiety (β = .36, p = .101). The results, again, suggested that depressive symptoms and social anxiety, is associated with the poorer Serial Recall for Social Threat words.

Table 5.8. *Curvilinear regression results of loneliness and loneliness residuals as independent variables and proportion of correctly recalled digits for Silent, Neutral, Social Positive, Physical Positive, Social Threat and Physical Threat conditions in the serial recall task at Time 2 as dependent variables.*

	Loneliness Results		**Loneliness residuals results**	
	β	Sig.	**β**	**Sig.**
Silent				
Linear Regression				
Loneliness	.46	.029*	**.40**	**.062***
Neutral				
Linear Regression				
Loneliness	.30	.163	**.35**	**.099***
Curvilinear Regression				
Loneliness	3.07	.072*	**.36**	**.102**
Loneliness^2	-2.79	.100	**-.10**	**.655**
Social Positive				
Linear Regression				
Loneliness	.30	.164	**.39**	**.066***
Physical Positive				
Linear Regression				
Loneliness	.33	.124	**.43**	**.040***
Curvilinear Regression				
Loneliness	3.39	.044*	**.44**	**.037***
Loneliness^2	-3.08	.064*	**-.18**	**.366**
Social Threat				
Curvilinear Regression				
Loneliness	2.95	.080*	**.36**	**.101**
Loneliness^2	-2.62	.118	**-.13**	**.531**
Physical Threat				
Linear Regression				
Loneliness	.44	.034*	**.43**	**.042***
Curvilinear Regression				
Loneliness	2.10	.201	**.41**	**.049***
Loneliness^2	-1.67	.305	**.23**	**.259**

Note. N=23

Emotional Stroop results for Time 1. Linear and curvilinear regression analyses were carried out to examine whether depressive symptoms and social anxiety have an imact on the association between loneliness and emotional Stroop task performances. The results are shown in Table 5.9. Interestingly, the results showed that, after controlling for depressive symptoms and social anxiety, the curvilinear regression effects of loneliness on cognitive performances weakened or disappeared. The results before controlling for depressive symptoms and social anxiety suggested that a higher level of loneliness is related to a slower reaction time

in naming the colour of Neutral (Loneliness: β = -1.70, p = .048*; Loneliness^2: β = 1.53, p = .074, one-tailed), Physical Positive (Loneliness: β = -1.93, p = .025*; Loneliness^2: β = 1.81, p = .035*), Physical Threat (Loneliness: β = -1.58, p = .067, one-tailed), Social Positive (Loneliness: β = -1.72, p = .046*; Loneliness^2: β = 1.59, p = .064*, one-tailed) and Social Threat words (Loneliness: β = -1.76, p = .041*; Loneliness^2: β = .16, p = .058*, one-tailed). However, those effects associated with Loneliness were weakened or disappeared after controlling for the effects of depressive symptoms and social anxiety on loneliness: Neutral (Loneliness: β = -.18, p = .120; Loneliness^2: β = .22, p = .064*), Physical Positive (Loneliness: β = -.13, p = .280; Loneliness^2: β = .22, p = .068*), Physical Threat (Loneliness: β = -.17, p = .152; Loneliness^2: β = .20, p = .086*), Social Positive (Loneliness: β = -.14, p = .240; Loneliness^2: β = .22, p = .059*) and Social Threat words (Loneliness: β = -.12, p = .291; Loneliness^2: β = .23, p = .048*). These results suggesting that the attentional biases towards information processing in lonely individuals may be largely related to the impact of depressive symptoms and social anxiety.

Emotional Stroop results for Time 2. A series of linear and curvilinear regression analyses were carried out for the reaction time results at Time 2 with loneliness score before and after, controlling for depressive symptoms and social anxiety. The results showed no significant effect of loneliness or loneliness residuals on the reaction time for naming the colour of Neutral, Social Positive, Physical Positive, Social Threat or Physical Threat words.

Table 5.9. *Curvilinear regression results of loneliness and loneliness residuals as the independent variables, the reaction time of naming the colour of Neutral, Physical Positive, Physical Threat, Social Positive and Social Threat words in the emotional Stroop task as dependent varibales at Time 1*

	Loneliness Results		**Loneliness residuals results**	
	β	Sig.	**β**	**Sig.**
Neutral				
Curvilinear Regression				
Loneliness	-1.70	.048*	**-.18**	**.120**
Loneliness^2	1.53	.074*	**.22**	**.064***
Physical Positive				
Curvilinear Regression				
Loneliness	-1.93	.025*	**-.13**	**.280**
Loneliness^2	1.81	.035*	**.22**	**.068***
Physical Threat				
Curvilinear Regression				
Loneliness	-1.58	.067*	**-.17**	**.152**
Loneliness^2	1.41	.101	**.20**	**.086***
Social Positive				
Curvilinear Regression				
Loneliness	-1.72	.046*	**-.14**	**.240**
Loneliness^2	1.59	.064*	**.22**	**.059***
Social Threat				
Curvilinear Regression				
Loneliness	-1.76	.041*	**-.12**	**.291**
Loneliness^2	.16	.058*	**.23**	**.048***

Directed Forgetting task results at Time 1. Linear and curvilinear regression analyses were carried out with loneliness and loneliness residual as independent variables, and the recall, recognition and tagging of the emotional words in the Directed Forgetting task as dependent variables. The results are shown in the Table 5.10 below. The results showed that after controlling the shared variance between depressive symptoms and social anxiety, the trend of loneliness on better recall of Social Threat Remember words (Linear regression: β = .21, p = .070, one-tailed) disappears, with the p-value decreasing from .070 to .236. Moreover, the effect of loneliness on the poorer recognition accuracy of Social Threat Remember words (Curvilinear: Loneliness: β = 1.67, p = .048*; Loneliness^2: β = -1.51, p = .073) and Social Threat Forget words (Linear: Loneliness: β = -.24, p = .037*) also disappeared (Social Threat Remember d': Loneliness: β = .09, p = .484; Loneliness^2: β = .05, p = .695; Social Threat Forget d': Loneliness: β = -.10, p = .403). After controlling for the covariates, the effect of loneliness on the recognition accuracy of Neutral Remember words, Social Positive Remember words, Neutral Forget words, and Social Positive Forget words became significant. The results suggest that the effect of loneliness on the memory bias for social threat remember words may be associated with depressive symptoms and social anxiety. Loneliness, on its own, has no impact on one's memory of Neutral and Social Positive information.

Table 5.10. *Linear and curvilinear regression analyses with loneliness and loneliness residual as independent variables, the recall, recognition and tagging of the emotional words in the Directed Forgetting task as dependent variables at Time 1.*

	Loneliness Results		**Loneliness residuals results**	
	β	*Sig.*	***β***	***Sig.***
	Recall			
Social Threat Remember				
Linear regression				
Loneliness	**.21**	**.070***	**.14**	**.236**
	Recognition Accuracy d'			
Neutral Remember d'				
Curvilinear Regression				
Loneliness	1.04	.228	**.20**	**.383**
Loneliness^2	-1.11	.197	**.27**	**.031***
Social Threat Remember d'				
Curvilinear Regression				
Loneliness	1.67	.048*	**.09**	**.484**
Loneliness^2	-1.51	.073*	**.05**	**.695**
Social Positive Remember d'				
Curvilinear Regression				
Loneliness	-.58	.504	**-.10**	**.419**
Loneliness^2	.61	.483	**.28**	**.026***
Neutral Forget d'				
Curvilinear Regression				

Loneliness	-.87	.311	**-.23**	**.066***
Loneliness^2	.74	.391	**.26**	**.033***
Social Threat Forget d'				
Linear regression				
Loneliness	-.24	.037*	**-.10**	**.403**
Social Positive Forget d'				
Curvilinear Regression				
Loneliness	-.59	.494	**-.03**	**.776**
Loneliness^2	.61	.481	**.33**	**.008****
Recognition Bias c'				
Physical Positive Remember c'				
Curvilinear Regression				
Loneliness	-1.25	.148	**.05**	**.678**
Loneliness^2	1.25	.148	**.28**	**.023***
Social Positive Remember c'				
Curvilinear Regression				
Loneliness	-1.04	.227	**-.09**	**.470**
Loneliness^2	1.12	.195	**.28**	**.023***
Physical Threat Forget c'				
Curvilinear Regression				
Loneliness	.68	.429	**-.12**	**.311**
Loneliness^2	-.82	.343	**.28**	**.026***
Physical Positive Forget c'				

Curvilinear Regression				
Loneliness	-.18	.837	**-.09**	**.458**
Loneliness^2	.30	.727	**.26**	**.034***
Social Positive Forget c'				
Curvilinear Regression				
Loneliness	-.01	.990	**-.16**	**.196**
Loneliness^2	-.07	.933	**.27**	**.027***
Tagging				
Physical Threat Remember				
Hit				
Curvilinear Regression				
Loneliness	-.44	.612	**-.27**	**.029***
Loneliness^2	.31	.717	**.17**	**.177**

N=74

Directed Forgetting results for Time 2. The results of loneliness and loneliness residuals in predicting the recall, recognition and tagging of words in the Directed Forgetting task at Time 2 are shown in Table 5.11. The results showed that after controlling for depressive symptoms and social anxiety, the effect of loneliness on the recall of Social Threat Remember words slightly increased (the beta weighted changed from .40 to .45, p-value increased from .057 to .031*. For recognition accuracy, the results of loneliness weakened or disappeared in the recognition of Neutral Remember words, Physical Positive Remember words, Physical Threat Remember words, and Physical Threat Forget words. However, the effect of loneliness on better accuracy of recognising Social Positive Remember words emerged after controlling for the covariates (β = .049, p = .030*).

Table 5.11. *Linear and curvilinear regression analyses with loneliness and loneliness residual as independent variables, the recall, recognition and tagging of the emotional words in the Directed Forgetting task as dependent variables at Time 2.*

	Loneliness Results		**Loneliness residuals results**	
	β	*Sig.*	***β***	***Sig.***
		Recall		
Social Threat Remember				
Linear regression				
Loneliness	.40	.057*	**.45**	**.031***
Curvilinear Regression				
Loneliness	.86	.610	**.44**	**.037***
Loneliness^2	-.46	.783	**.11**	**.599**
		Recognition Accuracy d'		
Neutral Remember d'				
Curvilinear Regression				
Loneliness	3.82	.039*	**.12**	**.633**
Loneliness^2	-3.73	.043*	**-.16**	**.514**
Physical Threat Remember d'				
Curvilinear Regression				
Loneliness	3.74	.036*	**.44**	**.042***
Loneliness^2	-3.46	.051*	**-.37**	**.086***
Physical Positive Remember d'				
Curvilinear Regression				
Loneliness	3.97	.031*	**.27**	**.265**

Loneliness^2	-3.90	.034*	**-.17**	**.284**
Social Positive Remember d'				
Linear Regression				
Loneliness	.20	.398	**.49**	**.030***
Physical Threat Forget d'				
Curvilinear Regression				
Loneliness	3.71	.043*	**.28**	**.234**
Loneliness^2	-3.50	.054*	**-.27**	**.239**

Summary of the Results of the Cognitive Study

The results after controlling the effects of depressive symptoms and social anxiety on loneliness showed that the effect of loneliness on better serial recall performance for the Social Threat and Physical Threat condition in the Serial Recall task disappeared. Moreover, the results for the effect of loneliness on the longer reaction time for naming Neutral, Social Positive, Social Threat, Physical Positive and Physical Threat words in the emotional Stroop task weakened or disappeared after loneliness score were controlled for depressive symptoms and social anxiety. In the Directed Forgetting task, the effect of loneliness on the recall and recognition of Social Threat words also weakened or disappeared, whereas the effect of loneliness on the recognition of Neutral and Social Positive words emerged even after controlling loneliness score for depressive symptoms and social anxiety. Therefore, for the cognitive study, depressive symptoms and social anxiety have a significant impact on the attentional biases and memory biases towards neutral and emotional information. In other words, depressive symptoms and social anxiety are more susceptible to be influenced by the task-irrelevant emotional contents in the cognitive paradigms used in the current thesis. Such finding suggests that the picture is less clear once we start to also examine the impact of depressive symptoms and social anxiety, as well as loneliness, on cognition.

Results of the Observational Study

Behavioural differences. The observation data was subjected to the Actor Partner Interdependence Model to examine how a person's loneliness level affects their own behaviour and their partner's behaviour during social interactions. The details of the analyses plan are in Chapter 4, page 241. Table 5.12 presents the results of the Actor-Partner Interdependence Model before and after controlling loneliness score for depressive symptoms and social anxiety. The results showed a slight alteration of coefficient value and significance levels after controlling loneliness scores for depressive symptoms and social anxiety (with the maximum variation of beta weights fluctuate by .01, and the maximum fluctuation of p values being from .048* to .053). For example, the actor effect (how a person's loneliness level affects her own behaviour social anxiety) of No Back Channel behaviour increased from β = .21 to β = .22, with the significance level remaining p = .002** after controlling for depressive symptoms and social anxiety. The partner effect of the No Back Channel behaviour, however, decreased from β = -.14, p = .048* to β = -.13, p = .053, after controlling for depressive symptoms and social anxiety. However, most of the results remain unchanged after controlling for the co-variates, suggesting depressive symptoms and social anxiety did not affect lonely individual's and their partner's behaviour in social interactions.

Table 5.12. *The APIMS results of loneliness and loneliness residuals and the behavioural differences in the social interaction*

	Actor effects with loneliness score	**Actor effects after controlling for covariates**	Partner effects with loneliness score	**Partner effects after controlling for covariates**
	Actor β	**Actor β**	Partner β	**Partner β**
Looking at Self	-.15 (*p*=.036*)	**-.15 (*p*=.038*)**		
Looking at Friend's non-face	-.18(*p*=.012*)	**-.17(*p*=.017*)**		
No Back Channels	.21(*p*=.002**)	**.22(*p*=.002**)**	-.14(*p*=.048*)	**-.13(*p*=.053*)**
Open Ended Question			.16(*p*=.019*)	**.16(*p*=.022*)**
Looking at Friend's Face			-.15(*p*=.028*)	**-.16(*p*=.024*)**
Sighing			.18(*p*=.008**)	**.18(*p*=.007**)**

Note. ***p<.001; **p<.01; *p<.05

Scorings of questionnaires. The results of loneliness residuals and the post-interaction questionnaires were shown in Table 5.13. The results showed that, after controlling for depressive symptoms and social anxiety, the actor effect of loneliness on individual's rating of the quality of interaction did not alter a great amount; the beta weights of loneliness slightly decreased in predicting a person's rating of themselves (Self-view) after controlling loneliness scores for depressive symptoms and social anxiety. There is a greater degree of alteration of partner effects after controlling for the covariates, with the statistical significance of the partner's rating of the quality of the interaction increasing, suggesting the effect of loneliness on the negative partner's rating of the interaction quality increased after controlling for depressive symptoms and social anxiety. However, despite the slight alteration of the effects before and after controlling for depressive symptoms and social anxiety, the covariates with loneliness did not provide significant alteration of the results in the direction or in the power of the effects. Therefore, depressive symptoms and social anxiety did not contribute to the association between loneliness and self, and partner's perceptions of the friendships and the quality of interactions.

Table 5.13 *The APIMs results of loneliness and Post interaction questionnaire before and after controlling for depressive symptoms and social anxiety*

	Actor effects with loneliness score	**Actor effects after controlling for covariates**	Partner effects with loneliness score	**Partner effects after controlling for covariates**
	Actor β	**Actor β**	Partner β	**Partner β**
Post interaction quality	-.29(*p*<.001***)	**-.29(*p*<.001***)**	-.13(*p*=.031*)	**-.13(*p*=.026*)**
Self-view	-.33(*p*<.001***)	**-.32(*p*<.001***)**		
View of other	-.25(*p*<.001***)	**-.25(*p*<.001***)**		
Other's self-view	-.27(*p*<.001***)	**-.27(*p*<.001***)**	-.14(*p*=.022*)	**-.14(*p*=.024*)**

Note. ***p<.001; **p<.01; *p<.05

The results of the relationships between Friendship Function questionnaires and loneliness before and after controlling for depressive symptoms and social anxiety are presented in Table 5.14. The results showed that, for actor effect, the standardized coefficient and statistical significant level increased for the relationships between loneliness and Companionship, Help, and Emotional Security after controlling for the covariates (Companionship: from β = -.25, p < .001*** to β = -.26, p < .001***; Help: From β = -.19, p = .002** to β = -.20, p = .002**; Emotional Security: from β = -.16, p = .009** to β = -.17, p = .006**). The results indicate that loneliness, regardless of the impact of depressive symptoms and social anxiety, predicted a more negative perception of a person's subjective ratings of their friendship functions. For partner effects, the results did not alter a great amount after controlling the loneliness score for the impact of depressive symptoms and social anxiety. The statistical significance level of the effect of loneliness on partner's

rating of the Help function slightly decreased (from $p < .001$*** to $p = .001$**), suggesting depressive symptoms and social anxiety may have a small impact on partner's perceptions of their friend's fulfilment of friendship functions.

Table 5.14. *The APIMs results of loneliness and Friendship function questionnaire before and after controlling for depressive symptoms and social anxiety*

	Actor effects with loneliness score	**Actor effects after controlling for covariates**	Partner effects with loneliness score	**Partner effects after controlling for covariates**
	Actor β	**Actor β**	Partner β	**Partner β**
Companionship	-.25(*p*<.001***)	**-.26(*p*<.001***)**	-.22(p<.001***)	**-.22(p<.001***)**
Help	-.19(*p*=.003**)	**-.20(*p*=.002**)**	-.21(p<.001***)	**-.21(p=.001**)**
Intimacy	-.19(*p*=.002**)	**-.19(*p*=.002**)**		
Reliable Alliance	-.26(*p*<.001***)	**-.26(*p*<.001***)**	-.17(p=.005**)	**-.17(p=.005**)**
Self-validation			-.19(p=.002**)	**-.19(p=.002**)**
Emotional Security	-.16(*p*=.009**)	**-.17(*p*=.006**)**	-.20(p<.001***)	**-.20(p<.001***)**

Note. ***p<.001; **p<.01; *p<.05

Summary of the Observation Study Results

The results showed a slight alteration in the beta weights and p-values of the effect of loneliness on social behaviour and social perception after controlling for depressive symptoms and social anxiety. However, the effects were only altered a marginal degree from the original results before controlling for the covariates. This indicates that the results can be reported without the depressive symptoms and social anxiety controlled.

Discussion

Loneliness is an independent construct that associates with depressive symptoms and social anxiety. However, previous research has not outlined whether controlling for depressive symptoms and social anxiety are necessary when conducting loneliness research. In the current thesis, the results of loneliness with and without controlling for depressive symptoms and social anxiety were compared with one another in the context of both the cognitive and observation study reported within the thesis. The results showed that the effect of the covariates differed between the results in the cognitive and observation study, with depressive symptoms and social anxiety play a role and dilutes the effect of loneliness on cognitive biases, but not for the impact of loneliness on social behaviour and perceptions.

For the Serial Recall Task, the results showed that after controlling for depressive symptoms and social anxiety, the effect of loneliness on the better Serial Recall performance when exposed to irrelevant speech comprising Social Threat and Physical Threat words disappeared. For the emotional Stroop task, the effect of loneliness on the slower naming of the colour of Neutral, Social Threat, Social Positive, Physical Threat and Physical Positive words was reduced or disappeared after controlling for depressive symptoms and social anxiety. Taken together, in terms of irrelevant auditory distraction stimuli, the effect of loneliness on a better Serial Recall, is associated with the influence of depressive symptoms and social anxiety. Since depressive symptoms and social anxiety may linked with a better ability in ignoring the task irrelevant sounds. For the visually presented task irrelevant stimuli, the effect of loneliness on the slower reaction time in naming the colour of neutral and emotional words were associated with depressive symptoms and social anxiety. Since depressive symptoms and social anxiety are linked to slower attentional control when processing of the task irrelevant information.

For the results of the Directed Forgetting task, the results showed that after controlling for depressive symptoms and social anxiety, the trend of loneliness on the heightened recall of Social Threat Remember words, and the poorer recognition of Social Threat Remember words and Social Threat Forget words, disappeared. Moreover, after controlling for the covariates, the effect of loneliness on the

recognition accuracy of Neutral Remember words, Social Positive Remember words, Neutral Forget words, and Social Positive Forget words became significant. The results suggest that depressive symptoms and social anxiety may have a significant influence on the effect of loneliness on memory biases of Social Threat Remember words and Social Threat Forget words. The change in results may be influenced by the tendency for depression to be associated with heightened recall of negative information (Matt, Vazquez & Campbell, et al., 1992). However, loneliness on its own, predicted better recognition of Neutral Remember, Neutral Forget, Social Positive Remember and Social Positive Forget words after controlling for the covariates of depressive symptoms and social anxiety.

The results provide important insights for the issue of controlling loneliness scores for depressive symptoms and social anxiety, because they suggest that loneliness itself is associated with heightened recognition of neutral and social positive information, the heightened recall of social threat remember words only arises when loneliness co-occurs with depressive symptoms and social anxiety.

For the observation study, results did not change after controlling loneliness score for depressive symptoms and social anxiety. The results suggest that loneliness on its own, has a significant impact on one's social behaviour and social perceptions, regardless of the impact of depressive symptoms and social anxiety. Therefore, taking the findings from the two studies together, depressive symptoms and social anxiety impact the association between UCLA loneliness score and the cognitive bias in relation to information processing (e.g., cognitive study), but not the relationships between loneliness social behaviour and social perceptions in the social interaction (e.g., observational study).

Implications for Future Research

Research should control for depressive symptoms and social anxiety in the study of cognitive biases, including both attentional bias and memory bias towards specific social information. Therefore, studies examining cognitive biases of lonely individuals should consider the impact of depressive symptoms and social anxiety carefully, and control appropriate covariates. In the observation study, the impact of depressive symptoms and social anxiety did not contribute to the changes in results,

hence the control of depressive symptoms and social anxiety may not be necessary when examining the behavioural features of loneliness.

Chapter 6: General Discussion

Prior research suggested that loneliness may affect human cognition in certain ways (Cacioppo & Hawkley, 2009). Specifically, lonely people were thought to have maladaptive cognitive features, such as blaming themselves for their social failure (Solano, 1987), and evaluating themselves and their social world negatively (Jones et al., 1981). Hawkley and Cacioppo (2010) argued that feeling lonely triggered implicit vigilance for social threat and increased feelings of vulnerability while raising the desire to reconnect. The current thesis set out to examine whether lonely people demonstrated cognitive biases in the cognitive and behavioural domain by using cognitive and social methodologies. Findings from the cognitive study showed that lonely people exhibited attentional and memory biases when processing emotional information. In the observational study, it was found that lonely people elicited negative social behaviour and held negative perceptions in a social interaction with a friend. Those findings extend previous work showing that cognitive processes are associated with loneliness and may impact social behaviour. Findings also have implications for interventions suggesting that those that focus on addressing negative social perceptions of threat are likely to be most effective.

Summary of Cognitive Study

The results of the cognitive study showed that individuals with higher levels of loneliness scores showed cognitive biases, including attentional and memory biases for emotional stimuli. Specifically, when processing task-irrelevant stimuli while performing a focal task, individuals with a higher level of loneliness showed slower automatic and strategic processing of neutral, physical positive, social positive, and social threat words (emotional Stroop task). However, when processing auditory task-irrelevant information, individuals scoring high on loneliness recalled more digits when there was no background sounds or when the irrelevant information consisted of Social Threat (e.g. hate, tease), or Physical Threat sounds (e.g. assault, cancer), (Serial Recall task). For memory processes, lonely individuals remembered more social threat words they had been asked to remember compared to non-lonely individuals. The brief results summary of the three cognitive tasks in the current study at two time points are shown in the table below.

Table 6.1. *Results summary of the cognitive study at two time points*

	T1	T2
Serial Recall	High lonely individuals are better at recalling digits with the background sounds of social threat and physical threat words	High lonely individuals showed better recall of digits with no background sounds, or when the backgrounds sounds were physical threat words
Emotional Stroop	High lonely individuals are slower at naming the colour of the neutral, social threat, social positive, physical threat and physical positive words.	No significant effects were found.
Directed Forgetting	High lonely individuals showed an enhanced memory of social threat words they were instructed to remember.	High lonely individuals showed an enhanced memory of social threat words with the remember instruction.

Attentional Bias: Differences between Visual and Auditory Stimuli Processing

For attentional bias, the findings suggest that lonely individuals show attentional biases towards emotional stimuli, but only when those stimuli are presented visually, not when they are presented aurally. Prior research suggested that higher loneliness scores are associated with an implicit hypervigilance to social threat (Cacioppo et al, 2015), and an attentional biases towards rejection information in a social context specifically (Bangee & Qualter, 2018). However, it is unclear whether lonely people show attentional biases when processing auditory stimuli and the current thesis filled the gap, providing important findings for the matter. Findings suggest that, in contrast to the visual attentional bias, lonely people do not show

attentional biases when processing auditory information; indeed, they execute the task better (recalled more digits) when physical threat and social threat sounds are presented as to-be-ignored background speech.

That finding may appear contradictory with previous research, but it is in line with the findings of fMRI work that has suggested irrelevant emotional stimuli may improve performance by speeding up conflict resolution (Kanske & Kotz, 2011; Max, Widmann, Kotz, Schröger & Wetzel, 2015). That is because emotional materials induce conflict processing in the dorsal anterior cingulate cortex, the right ventral anterior cingulate cortex and amygdala, the prior two parts of the brain are related to executive control while the lateral part of the brain involves fear response, these brain parts work coordinately to enhance the conflict resolution elicited by emotional materials and enhanced processing speed (Kanske & Kotz, 2010). However, the speeding effect may be more likely to happen, when the emotional information are separate from the study content, such as in the Serial Recall task, the sounds are not part of the task (recalling the serial of the digits presented). However, when the irrelevant emotional content were presented as part of the study, such as in the emotional Stroop task, the content of the word was presented as part of the study (colour of the text), may increase the processing time.

The results suggested a maladaptive attentional process in lonely individuals.Whether advanced processing of auditory content is a trade-off for the visual attentional bias, or it is a learnt coping strategy for suppressing threat information to complete everyday tasks, is unclear. However, the results clearly indicate that lonely people may have different types of processing of sensory information in relation to threat materials. From an evolution point of view, the processing of sounds and image determine perceptions concurrently (Musacchia et al., 2008), the integration of audiovisual models suggest that information from different modalities is processed hierarchically in unisensory stream and converge for higher order structures (Massaro, 1998). Therefore, it is likely that high lonely people may selectively choose visual information rather than auditory information for subsequent emotional responses after receiving the sensory information.

The findings also provide insights for developing future cognitive paradigms when examining auditory and visual processing of emotional stimuli in lonely

people. The processing of auditory events that can capture attention is attenuated when participants are engaged in a focal task. Engagement can be increased via presenting stimuli is a more difficult to read font or by overlaying stimuli with Gaussian visual noise (Marsh et al., 2018). It would be interesting to see whether presenting valent stimuli as to-be-remembered material instead of digits, results in heightened task engagement and as a consequence, reduced processing of background sound. Therefore, it is entirely possible that attentional capture produced by a rare auditory object—such as a change in voice in an otherwise repetitive stream of spoken-tokens—could be resisted if the to-be-recalled items were valent words as compared to digits.

Another explanation of the divergence in visual and auditory information processing may be related to the different brain activation patterns in lonely people. Prior EEG and fMRI research has established that people scoring high on loneliness showed a heightened activation in the visual cortex when viewing social threatening images (Cacioppo et al., 2009), but the brain area related to the processing of sounds are different from the processing of visual stimuli. Therefore, future research focus on the area in the brain related to auditory processing, such as brainstem processing (Sörqvist, Stenfelt & Ronnberg, 2012) and explore whether this response is different for lonely as compared with non-lonely individuals when viewing threatening images. To elaborate, after reaching the ear and cochlea sound is converted in a neural signature. Its transmission then passes through the olivary complex and brainstem prior to arriving at the thalamus and auditory cortex. Sörqvist, Stenfelt, and Ronnberg (2012) measured the auditory brainstem response to sound via evoked potentials. They showed that fewer neurons in the brainstem fired in response to sounds when participants were engaged in a demanding visual task—a 2 or 3-back version of the n-back task—as compared to the 1-back version of the task. In the n-back task participants are presented with a pseudorandom sequence e.g., of seven letters and participants are instructed to press a key when the currently presented letter was the same as that presented n letters back in the sequence. If valent material such as visual images occupied more working memory or cognitive resources for high lonely as compared to low lonely participants, then it is possible that a reduction in the auditory

brainstem response would be shown for high lonely participants, further supporting the notion that they have an attentional bias toward threat material.

Moreover, as outlined in the literature review, only a handful of studies have explored attentional biases in lonely people using the typical cognitive paradigms, such as emotional Stroop (Cacioppo et al., 2015), dichotic listening (Cacioppo et al., 2000), or the Serial Recall task (Harris, 2014 and in the current study). Therefore, more research using classic cognitive paradigms such as dot probe and flanker tasks, to examine whether the attentional biases exhibited in lonely people is needed.

Memory Bias

The current thesis conducted a Directed Forgetting task to examine whether there are memory biases in individuals with higher loneliness scores. In the Directed Forgetting tasks, participants were presented with a series of Neutral, Physical Threat, Physical Positive, Social Threat and Social Positive words, followed by either Remember or Forget instruction. Participants were told to remember the words followed by a Remember instruction at the initial encoding stage, but were testing for all the words that they have remembered at the recall stage. With regards the findings of the memory study, a higher level of loneliness was linked to a better recall of social threat Remember words amongst other emotional and neutral words. This finding suggests that higher levels of loneliness are associated with an increased accessibility of negative self-referent information, that is, socially threatening words, may have a negative impact on the evaluation, perceptions and anticipations of social interactions. Because memory biases often influence people's perceptions, judgements, anticipations, and subsequently affect how a person controls their attention (Gotlib & Joormann, 2010), the heightened accessibility to social threat information could impact a person's emotional response to social situations, and the choice to use different emotional regulation strategies. Such findings offer opportunities for intervention work, which should be explored in future work.

Although much research suggests that loneliness is associated with memory bias towards social information (Cacioppo & Hawkley, 2009; Spithoven et al., 2017), not many studies have been conducted in this area. One of the studies that

examined this issue was conducted by Gardner et al., (2005). In that study, participants were instructed to read made-up diary events containing neutral, individuals social and collective social events, and were tested the amount of events they can recall after completed a math task. The findings of their study showed that high lonely individuals recalled both more positive and negative social information. The current study replicated the findings in the Gardner task using a different experimental design, suggesting that the effect is a robust one. The current study, in line with Gardner's research, demonstrated that high lonely individual showed a memory bias towards socially threatening information amongst individual, unrelated words, but they have a memory bias for social information when processing of cohesive sentences and logical events. By offering further evidence for the memory biases towards social threat information, the current work has implications for the theory of loneliness and for intervention work.

Given that memory bias plays an important role in emotional regulation (Zupan, Žeželj & Andjelković, 2017), which is positively associated with emotional well-being. An intervention that focuses on building emotion regulation skills might be effective for lonely people. For example, remembering more positive events and forgetting negative events is associated with an increased well-being across life (Charles, et al., 2003), whereas an inability to recall or use positive memory to regulate negative mood states may increase one's feelings of loneliness. With high lonely individuals, who are characterised by remembering more socially threatening content, i.e. the social threat words, could impair their ability of emotional regulation in a long term, and results in more negative cognitive, social and emotional problems. In intervention work, by focusing on emotion regulation and building skills to focus more on the positive rather than the negative, we would expect to see changes in loneliness and overall well-being.

Implications of the Longitudinal Study

The current thesis also aimed to examine whether loneliness across time has an impact on the cognitive processing of emotional information and vice versa. The results of the longitudinal study showed that loneliness not only affect cognitive processing concurrently but also over time. Meanwhile, a heightened cognitive bias towards social information also contributes to the increase of loneliness score across

time. For example, in the Directed Forgetting task, a high level of loneliness at time point one predicted a better recall of social threat words at time point two. In the same task, a better recall of physical threat remember words at time point one predicted an increase of loneliness score at time point 2.

The results support the argument that loneliness and cognitive biases predict each other over time, and cognitive biases contributed to the development and maintenance of loneliness. Those findings are novel as they tap into the mechanisms of maintenance of loneliness, and highlighted the importance of the role of cognitive biases on the development of loneliness. The bidirectional effect suggests that the link between loneliness and cognitive bias are often co-occurred. Feeling lonely changes people's experience of the world, with the attention and memory bias altered the way people process emotional information: it creates or reinforces the beliefs about they will be rejected, and the social world is a threatening place. It may then affect the person's emotional regulation ability, and lead to subsequent behavioural withdrawal and enhanced the feelings of loneliness. In the end, the person re-engages in a self-fulfilling circle and it becomes more difficult for them to build meaningful connections with other people. This idea was first proposed by Cacioppo and Hawkley in 2009, but has not been examined before using longitudinal data. While the current study includes only a very small sample, the findings offer the first evidence supporting Cacioppo and Hawkley's claim using longitudinal data.

During the write-up of the PhD, another study was published that also examined the longitudinal relationships between loneliness and memory function. Ayalon, Shiovitz-Ezra & Roziner (2016) studied loneliness and memory function longitudinally and found that lower levels of memory functioning precedes higher levels of loneliness 4 years afterwards, but not the other way round. However, that study did not test for the memory biases towards threat in line with the threat sensitivity hypothesis proposed by Cacioppo and Hawkley (2009), but examined explicit memory deterioration, including immediate recall and delayed verbal recall. However, findings from that study, the current study, and a handful of other memory studies (for example, Gardner et al., 2005; Harris, 2014, Spithoven et al., 2018) highlight the importance of memory functions in relation to the development and

maintenance of loneliness, and provide evidence for the link between loneliness and poorer cognitive functions.

In conclusion, irrelevant auditory and visual distractors in the environment may affect individuals' attention and memory, lonely individuals are more susceptible to distraction via task-irrelevant emotional materials cross-sectionally and longitudinally. This suggests that high lonely individuals have difficulties in adjusting attentional and memory resources when focusing on the task in hand.

Summary of Observation Study

The current thesis included an observation study to examine the social interaction and perceptions of high lonely individuals. Female university students were invited to complete a 15-minute interaction and rated their perceptions of the interaction, and perceived friendship quality afterwards. The results of the current observation study showed that females with a higher level of loneliness scores showed more "no back channel" behaviour to their friends, a behaviour that occurs when a person does not respond to their partners. Friends of the lonely females showed more prosocial behaviour, such as asking more open-ended questions, but they were less interested in their friends. The results confirm that lonely individuals have more negative social interactions, and they showed more withdrawal behaviour during these interactions with their same sex friends. Moreover, according to previous literature that investigated the social behaviour of lonely people, it was unclear whether lonely people had actual social skills deficits or only perceive that they have poorer social skills. The results of the behavioural analyses showed that lonely participants showed both perceived and actual social skills deficits during social interaction.

The findings of the current study support those from previous observation work conducted by Bell (1985) and Jones, et al. (1982). Those prior studies examined the social behaviour of lonely individuals when interacting with an opposite-sex stranger, where it was revealed that high lonely individuals showed a negative interaction style with an opposite-sex stranger, with lonely participants having a lower level of talkativeness, interruptions, vocal back-channels, and attention (Bell, 1985), and giving less attention to their partner (Jones et al., 1982).

The current thesis explored whether lonely people showed those same patterns of behaviour with a friend, and findings offer support to the idea that there may be a negative behavioural profile linked to loneliness. Combined with findings from prior work, lonely individuals appear to interact in a negative way, and they are less responsive in most of their social interactions.

Partner's behaviour. The current observation study is the first examining the friends' social behaviour towards lonely people. The results showed that friends of lonely females showed more prosocial behaviour towards lonely individuals, but they are less interested in their friends. Specifically, friends of high lonely females asked more open-ended questions, showed less "no back channel" behaviour, but they looked less at their friends' face, and sighed more during the interaction. The findings supported the social skills deficits (Jones et al., 1982; Segrin & Flora, 2000) view indirectly, and provided important observation evidence of how lonely people interact with their friends on a regular basis, but important other information was also gathered, offering the first empirical examination of the social interaction patterns used by people who regularly interact with lonely people.

An Integrated Account between the Lonely Friendship Dyads

Previous research reported that others do not always report an unfavourable impression of lonely people (Solano & Keoster, 1989), but the social behaviour of lonely people's friends are not fully examined. The results of the current study showed that, although the partner's behaviour in the current study contains both positive and negative social cues, the positive social cues were somehow ignored by lonely females. Considering high lonely people tend to focus on the socially threatening information (Bangee, et al., 2014; Qualter et al., 2013) during a course of viewing a short video clip display children play on the playground, it is likely that their attention may be diverted to the negative social cues of their partners in actual social interaction. The positive social message from their partners, such as asking for more open ended questions, or responding to lonely people more often, are more likely to be ignored because of their cognitive biases.

The findings that people engaged with lonely individuals and respond positively is not necessarily what would be expected based on the work on stigma

and loneliness (for example, Lau & Gruen, 1992; Rotenberg & Kmill, 1992). According to the account of the stigma of loneliness, a person who fulfilled the descriptions of the lonely stereotype were often viewed negatively by other people (Lau & Gruen, 1992). The findings in the current observation study suggest that there is less stigma surrounding loneliness when friendship exists between the perceiver and the target. The findings of the observation suggest that (1) people appear to know that their lonely friends' need help and support during the interaction even without there being explicit discussion of that, and (2) people respond positively by trying to get their partner to engage suggests that friends may want to provide a positive social environment for lonely people. Moreover, results showed that the passivity and lack of response of lonely people when interacting with their friend, is not because the friends are too talkative or being too dominant.

Suggestions for Designing Future Observation Research for Loneliness

Future research should focus on exploring lonely people's social behaviour when interacting with a stranger. It is unclear whether high lonely individuals, and their partners, exhibit similar patterns of behaviour during social interactions. Therefore, future research should explore whether the findings from the current study would replicate with non-friend dyads. Moreover, future research should involve conducting observation studies with male friendship dyads and group interactions to identify the behavioural and perceptual differences of lonely male individuals. It is expected that high lonely males may be perceived more negatively by their friends because of the stigma of loneliness (for example, see Lau & Gruen, 1992). Moreover, lonely males may spend less time talking and have a less intimate conversation with their friends compare with non-lonely males (Sloan & Solano, 1984).

Future observational work should look at friendship dyads made up of lonely-lonely, lonely-non-lonely, non-lonely-non-lonely people. There may be different patterns of behaviour for partners in those situations. Both members of the dyads in the lonely-lonely group may show more withdrawal behaviour compare with individuals in the non-lonely, non-lonely pairs. The interaction style of lonely-non-lonely group may differed by gender, because the stereotype of a lonely male were more stigmatised than the lonely female stereotype (Lau & Gruen, 1992),

therefore, more negative partner behaviour may be found in the non-lonely male friend of a lonely male, compare with the non-lonely friend of a lonely female.

Intervention Insights Based on the Findings of the Observation Study

The results provide further insights in developing intervention programs for individuals with higher loneliness scores. Previous research outlined that addressing maladaptive cognition is considered to be the most useful intervention program comparing with increased social support or improved social skills for high lonely individuals (Weis et al., 2005). However, the findings from the current study suggest that lonely people do lack social skills, as they are less responsive towards their friends. Therefore, intervention programs designed to improve specific social skills, such as partner attention or social awareness training may help lonely individuals to understand the needs of others' in social interactions. Moreover, as friends of lonely people respond more often, and ask more open ended questions directed towards the lonely people during the interaction, an intervention program designed to focus on the positive cues in social interactions may be useful to tackle loneliness and poorer social relationships.

Perceptions of self and others, interaction quality and friendship quality. The results also showed that females with higher levels of loneliness and their friends, tended to rate their interaction as being of poorer quality. Lonely participants, compared with non-lonely individuals, rated themselves and other people more negatively. Moreover, both members of the dyads rated their partners as having a more negative self-view, with lonely females matching this view by attributing a negative self-evaluation, whereas their friends, did not report a negative self-view matching lonely females' perceptions. Such findings suggest that high lonely participants tend to see their world more negatively when evaluating their social interactions with a friend compared with non-lonely individuals. They may also misinterpret their friend's behaviour, and this may be caused by them projecting their own view of themselves, or only seeing negative, self-loathing cues of other people, and perceived others based on these observations.

Furthermore, both members of the dyads filled the friendship function questionnaire, which measures how much their friends fulfilled various friendship function, for example, companionship, help, emotional security etc, in their

friendship. The results showed that both parties of the dyads reported their friends as lacking in terms of fulfilling various friendship functions, suggesting lonely females have poorer functional friendships with their same-sex friends. These friendships, are less socially efficient and did not provide sufficient support against loneliness. Instead, they may trigger more negative social interactions, and negative perceptions. Therefore, maintaining these friendships may become difficult in the long term.

The results of the post interaction questionnaire replicate the findings of Jones et al. (1981), Christensen and Kashy (1998), Tsai and Reis (2009), which highlights lonely university students tend to evaluate themselves more negatively compare with non-lonely university students. The results support the behavioural confirmation hypothesis (Rotenberg et al., 2002) that lonely people have negative beliefs about themselves and that affects how they interact with others and how others perceive and interact with them. The findings in the current study have further implications for developing intervention programs for loneliness. The results of the current thesis highlighted that high lonely people hold negative perceptions of themselves and their friends. Therefore, it is important to address this maladapted social cognition. Future intervention should not only focus on the negative self-perceptions, but also the negative perceptions of others and the negative judgement of others. Moreover, future studies should focus on improving the friendship quality of lonely individuals. Because friendship links to various aspects of emotional wellbeing (Rowsell, 2015), future interventions designed to improve friendship quality by tapping into each of the friendship functions measured in the current study should be undertaken.

Differences between friendships that have lasted a different length of time. The social interactions, and the perceptions of their friendship are different in the long friendship dyads and the short friendship dyads, with high lonely individuals and their friends in the long friendship reporting fewer negative perceptions of the friendships and themselves after the interaction, compared with dyads in the short friendship groups. Therefore, future intervention should focus on reconnecting high lonely individuals with friends whom they have been in a friendship with for a long time. Because friends of lonely females rated high lonely individuals more positively after the interaction, future intervention programs should

present opportunities for high lonely individuals to interact with friends who they have known for a longer period of time.

Differences between Lonely Adults and Children in Cognitive Biases and Social Responses

Cognitive processing differences between children and adults. The current thesis provided findings of cognitive biases among lonely adults, and the findings, when compared to previous studies with children, suggest there may be a difference in the cognitive processing profiles across ontogeny. The summary of the differences in cognitive and social responses between lonely children and adults are shown in Table 6.2. For auditory distraction, high lonely adults were less distracted by physical threat sounds and social threat sounds when completing the serial recall task. Lonely children, however, showed a general poorer serial recall performance that cut across all categories of emotional words presented as to-be-ignored sounds. For visual attention, the different pattern of attentional bias between children and adults was also evidenced in eye tracker studies conducted by Qualter et al. (2013) and Bangee, et al. (2014). These showed that lonely children gazed longer at socially threatening materials when viewing a video clip of children in the playground, whereas adults showed an initial focus on the social threat scene but quickly disengaged from it. Moreover, for memory bias, high lonely children showed no differences in memory of social events (Harris, 2014), whereas lonely adults showed better recall of social threat remember words amongst all the other categories of words (as showed in the current study).

Furthermore, the findings of the current observation study revealed that high lonely adults and children showed different social behaviour in social situations, with lonely children showing both prosocial and withdrawal behaviour (for example, Qualter & Munn, 2002, 2004), whereas lonely young adults showed withdrawal behaviour only. Therefore, there may be clear differences of behavioural patterns of loneliness in childhood and adulthood. Many studies examining lonely adolescents' perceptions of friendships showed that lonely adolescents adopt a pretty much similar social strategy, social perceptions as lonely adults (for example, Lodder, et al., 2016; Vanhalst, et al., 2013), whereas lonely children tend to show a different pattern of results from lonely adolescents and adults. Therefore, the prosocial

behaviour in loneliness in childhood might be associated with different types of judgements, orientation and understanding of self and others. Because of the differences between the children and adults' cognitive and social responses, future research should tap into the different loneliness mechanisms that are related to age, in order to design different interventions for lonely children and adults.

Table. 6.2. *Brief summary of cognitive and observation study findings in children and adults*

	Cognitive Study	Observation Study
Children	Attentional biases: lonely children showed poorer performance on serial recall when to-be-ignored sound contained the content of sound, regardless of the valence. High lonely children tend to focus on social threat scenes in eye tracking studies. Memory biases: children showed no memory biases for social information.	Lonely children showed both prosocial behaviour and negative social behaviour and they were perceived positively by their peers.
Adults	Attentional biases: lonely adults are better at serial recall with social threat and physical threat to-be-ignored sounds in the background. High lonely adults showed initial vigilance towards a social threat scene but quickly disengaged from it. Memory biases: lonely individuals showed memory biases towards social threat words they are instructed to remember.	Lonely adults showed more withdrawal behaviour in interactions and they were perceived negatively by their friends.

The Impact of Depressive Symptoms and Social Anxiety

The results of the current set of studies showed subtle differences after controlling for depressive symptoms and social anxiety. For example, after controlling for the influence of depressive symptoms and social anxiety on performance in the emotion recognition tasks, the effect of loneliness in recognising sad and fear faces became stronger, and the correlation between loneliness and recognising happy faces disappeared (Vanhalst, Gibb & Prinstein, 2015). In contrast, other research has found no difference in the results of loneliness after controlling for depressive symptoms (for example, Lodder et al., 2015)

Depressive symptoms and social anxiety share many important cognitive and behavioural features as loneliness. For example, depressive symptoms are related to a heightened recall of negative information (for example, Mathews & MacLeod, 2005), whereas social anxiety is related to increased fear and tension behaviour in social interaction (Heerey & Kring, 2007). The findings of the current thesis showed that depressive symptoms and social anxiety had a significant impact on the relationships between loneliness and cognitive biases, but not the relationships between loneliness and social behaviour or social perceptions. The results of the cognitive study showed that after controlling for depressive symptoms and social anxiety, the effect of loneliness on the heightened recall of Social Threat Remember information disappeared, whereas the effect of a better cognition for Neutral and Social Positive information were still evident. On the other hand, the effect of loneliness on social behaviour and social perceptions did not alter a great degree after controlling for depressive symptoms and social anxiety. The current study provides important insights that loneliness, depressive symptoms and social anxiety are distinctive constructs that are each associated with cognitive biases exhibited in different tasks. That is also in line with previous research such as that of Lan et al. (2016) who used fMRI. They found that loneliness and depressive symptoms are associated with different brain activation patterns. However, because there are overlapping affective, cognitive, and behavioural features of loneliness, depressive symptoms, and social anxiety, it is important to control for these variances when examining loneliness in future research. Only a few studies have done that, but more

research needs to be conducted to disentangle the impact of loneliness, depressive symptoms, and social anxiety on individuals' cognitive and social responses.

Gaps Left to be Filled

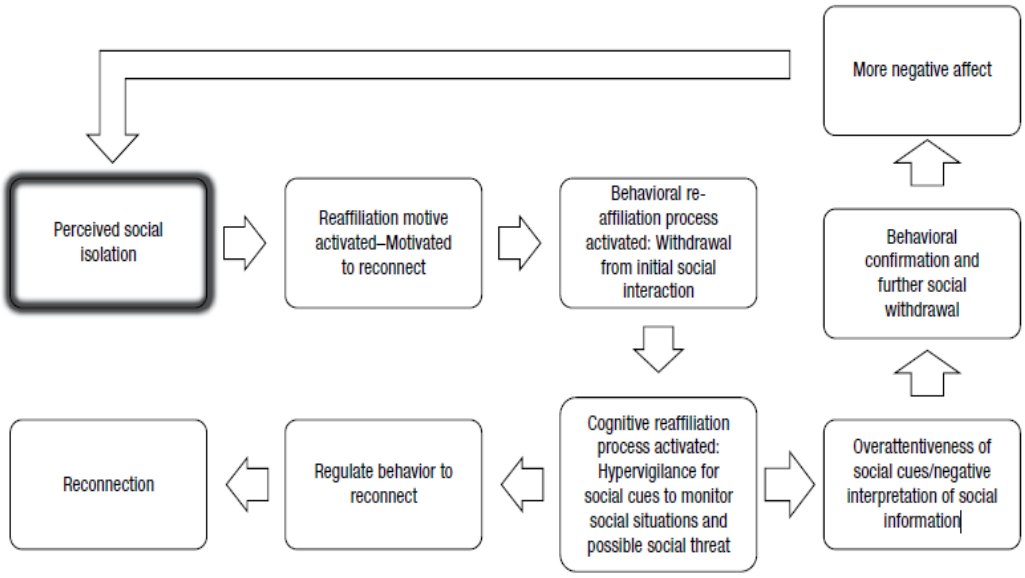
Although the current thesis examined loneliness and cognitive biases and social behaviour thoroughly, many gaps still need to be addressed. First of all, although previous research outlined the changes of cognitive biases, social behaviour, and social perceptions from children to adolescents and adulthood (Qualter, et al, 2015), more research needs to be conducted in examining and summarising the differences between the manifestation of loneliness in youth and adults. An increasing amount of research has shown that children's cognitive biases and social behaviour are different from adults'. Thus, it is important to construct theoretical models of loneliness that acknowledge developmental changes.

Second, because there is no clinical diagnostics of loneliness, most of the research in the field does not differentiate the impact of chronic versus transient loneliness. According to previous literature, prolonged loneliness and transient loneliness are different in the cognitive, affective, and behavioural mechanisms (Hawkey & Cacioppo, 2010). There are few longitudinal studies that have examined the impact of loneliness on the cognitive and behavioural domain. Therefore, longitudinal studies in the future are needed to fill important gaps in the knowledge base. Moreover, future research should attempt to desig questionnaires measuring transient and chronic loneliness separately, which will resolve this problem that has been overlooked for a long time, so that future studies of loneliness can be more specific about the degree of loneliness of the sample being measured.

Third, future research should focus on the protective factors against loneliness. This will not only be beneficial for any future intervention program, but also separate the differences between chronic and transient loneliness. To date, the protective factors of loneliness include social engagement and connectedness (Flood, 2005), a sense of belongingness (Baskin et al., 2010), and having at least one confidant and academic achievement (Hall-Lande, 2007). For individuals in old age, advanced age, and having a post-basic education level are independent protective factors of loneliness (Victor et al., 2005). Much research has explored the

mechanisms of development and maintenance of loneliness, but not many studies have explored how people escape from self-perpetuation circle of loneliness. So far, the Re-affiliation model proposed by Qualter et al. (2015), see Figure 6.1, showed that the separation from loneliness reduction and loneliness perpetuation path was at the cognitive re-affiliation stage. Future research should focus on how to improve this model by exploring what may be the reason causing the successful cognitive re-affiliation.

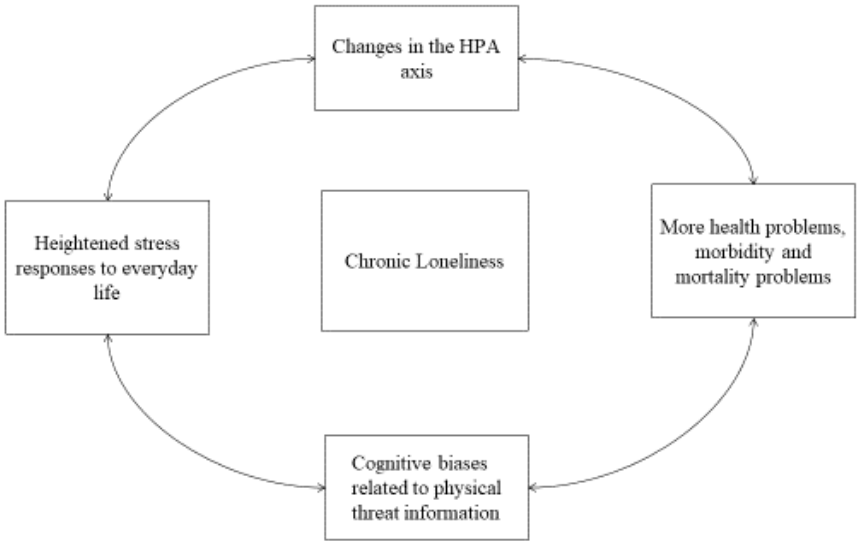
Figure 6.1 The Re-affiliation model (Qualter et al., 2015)



Fourth, future research should include a health path in the current theoretical model. The potential impact of loneliness on physical health is shown in Figure 6.2 below. As outlined in prior research, loneliness is associated with a heightened perception of everyday stress level, and an increased likelihood of developing cardiovascular diseases (Cacioppo et al., 2006), a more activated HPA axis, and an increased morbidity and mortality at old age (Cacioppo & Hawkley, 2009). Moreover, the impact of stress is related to both cognitive and social maladjustment. For example, the current study showed that individuals reporting a higher level of loneliness showed cognitive biases to physical threat words, which may be related to the induced stress response when processing this information. Moreover, some argue that the development of loneliness is related to a diathesis-stress model, which

supports the notion that both social skills deficits and stress situations could trigger the development of loneliness (Segrin & Flora, 1999).

Figure 6.2 The potential health path in relation to loneliness



Apart from the findings regards loneliness and cognitive biases towards physical threat words, another directions for future research, based on the current thesis findings lies in the impact of depressive symptoms and social anxiety on loneliness. Future studies should control for the impact of depressive symptoms and social anxiety on loneliness. The results of the current set of studies showed differences in the results after controlling for depressive symptoms and social anxiety. Because loneliness is a subjective experience interrelated with depressive symptoms (Dill & Anderson, 1999) and social anxiety (Vanhalst et al., 2015). Therefore, individuals may experience loneliness differently when it co-occurs with depressive symptoms or social anxiety, and that should be explored in future research. Given the overlapping affective, cognitive, and behavioural features of loneliness, depressive symptoms, and social anxiety, it is important to control for these variances when examining loneliness in future research.

Implications for Interventions

The results of the current study provide some ideas for developing future interventions for loneliness, and some of those have been mentioned. Previous research indicates that addressing maladaptive cognitive features may be the most effective method in reducing loneliness, whereas the methods related to enhance social support, improve social skills and increase social opportunities were also effective but to a much smaller degree (Masi et al., 2011). The results in the current research agreed with the findings in parts, although the method of addressing maladaptive cognition may be the most useful amongst these methods on its own, interventions combining attentional and memory biases training, social skills training and addressing maladaptive cognitions may be the most effective for individuals experiencing different aspects of loneliness. The findings from the current thesis suggest that designing an intervention for loneliness should combine the aspects of both cognitive and social methods.

Current findings suggest that suitable interventions for loneliness should involve trainings to remove cognitive biases for high lonely individuals. This could involve training to redirect attention and memory towards socially desirable information. The focus of intervention should include social training too, such as social skills practices, increasing social support from close friends, and addressing negative social cognition. The findings from the observation study support the latter idea because the differences between lonely and non-lonely people seems to primarily concern self-perceptions rather than actual behaviour.

Moreover, as long as designing interventions concerning the social and cognitive aspects, the interventions for loneliness should consider individual differences. Moreover, because loneliness is a subjective experience, every person's experience may not be entirely the same. That needs to be reflected in interventions somehow. Rokach (1988) argued that the experience of loneliness may be categorised into 4 main components, including self-alienation, interpersonal isolation, distressed reactions, and agony. Individuals may experience all four aspects of the feelings or may not experience all the sub factors of each of the components. Therefore, intervention programs should be designed for individuals with different needs in relation to their feelings of loneliness. For example, for

people experiencing severe stress maladaptation, the intervention program should include medical interference or therapies that may reduce the effects of stress. In consideration of the impact of depressive symptoms and social anxiety, interventions should consider the impact of the co-variance between depressive symptoms and social anxiety on different aspects of a person's social wellbeing.

Conclusion

The current thesis aimed to address significant gaps in the previous literature, including whether lonely individuals (1) have attentional and memory biases towards socially threatening information, and (2) demonstrate behavioural withdrawal and negative perceptions in social relationships. The results of the cognitive study suggest that feeling lonely is associated with enhanced task-in-hand performances when to-be-ignored background sounds conveyed social threat or physical threat information. However, lonely individuals showed a difficulty in making the colour judgement in the emotional Stroop task (with both slower latency and poorer accuracy), where the task irrelevant dimension of the visual stimuli is concerning neutral and emotional stimuli, but the task-relevant visual cues were the colour. For memory processes, lonely individuals showed a memory bias towards social information that is instructed to be remembered. The results of the observational study show that lonely people tend to experience poor quality social interaction and they tend to think of themselves and the friend they interacted with negatively compared with non-lonely people. The contribution of the current thesis to the present current loneliness literature has been considered and through this evaluation has raised new questions and potential investigations for future research.

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Appendix 1. Associate Factors of Loneliness in University Students

Introduction

Loneliness is characterised by a series of affective, cognitive and behavioural features that relate to interpersonal difficulties and a negative self-concept (Heinrich & Gullone, 2006). Loneliness is associated with low self-esteem (Vanhalst, et al., 2013), low self-efficacy (Al Khatib, 2012), and exhibition of cognitive biases in the social domain (Spithoven, 2017).

Loneliness is particularly salient in university students. Indeed, loneliness is displayed as a U-shape with people under 25 and older than 65 being the most lonely (Victor & Yang, 2012). Moreover, previous research outlined that college students (M_{age} = 25.29, SD = 8.01) are more likely to experience loneliness (Wiseman, Guttfreund, & Lurie, 1995). A study conducted by Knox, Vail-Smith and Zusman (2007) found that 25.9% of college male students and 16.7% of college female students had severe loneliness feelings. In the US, approximately 30% of college students experience loneliness, with 6% being considered as a severe problem (Knox et al., 2007).

Furthermore, along with loneliness, university students report more clinical, psychological, and social-emotional maladaptation. For example, the prevalence of university students in a recent Australia university who were diagnosed with mild to severe depressive symptoms was 39.5%, with 13% being in the extreme range (Schofield et al., 2016). For social anxiety, a series of studies concluded within universities in the UK and Sweden showed the clinical significant levels of social anxiety is at 10% to 16% (Russell & Shaw, 2009; Tillfors & Furmark, 2006).

Therefore, university life may be a significantly vulnerable period of time for experiencing psychological and emotional maladjustment. Therefore, the current study examines the relationship between loneliness and the psychological and social-emotional factors among a university student sample. To investigate the topic, the current study selected a series of questionnaires measuring these factors, including Depressive Symptoms, Fear of Negative Evaluation, Interaction Anxiousness, Trait Emotional Intelligence, Social Desirability and Trust Beliefs to examine the correlations of loneliness and other interpersonal difficulties.

Psychological and Social-Emotional Factors Related to Loneliness

Loneliness is a multifaceted experience, it has several dimensions, and complicatedly interacts with physical, social and psychological factors (Heinrich & Gullone., 2006, Cacioppo & Hawkley., 2009). Loneliness is interrelated with more negative psychological and social-emotional factors, for example, trust-beliefs (Rotenberg, 1994), fear of negative evaluation (Cacioppo et al., 2000), and with less positive factors, such as lower emotional intelligence (Zysberg, 2012) and social desirability (Caputo, 2017).

Loneliness and depressive symptoms. Loneliness is considered to be an aspect of depression for many decades (Young, 1982). A cross-sectional study examined the relationship between loneliness, age, and depression, and showed that depression is the only factor related to loneliness at all ages (Victor & Yang, 2012). Previous research outlined that loneliness and depression share some common features, for example, poor social skills, shyness, and a maladaptive attributional style (Dill & Anderson, 1999). In addition, the correlation of loneliness and depression ranges between .40 to .60 in adults (Heinrich & Gullone, 2006) and between . 55 and .62 in adolescents (Mahon et al. 2006). Research shows that loneliness and depression are distinct phenomena and loneliness may increase the risk of depression.

Loneliness and social anxiety. Empirical investigations have linked loneliness to social anxiety. Social anxiety is characterised by an excessive fear of social situations or negative evaluations from others (American Psychiatric Association, 2013). Loneliness and social anxiety may link strongly because they share an important common cognitive feature, i.e. hypervigilance to social threat (Lim et al., 2016) and negative social perceptions (Clark, 2001). Moreover, in the behavioural domain, socially anxious individuals tend to show an elevating self-focused attention in social situations (Clark, 2001) and this pattern of focus impacts individual's social behaviour which is also salient in lonely individuals (Jones, et al., 1981)

Loneliness and trust beliefs. Research showed a consistently strong negative link between loneliness and Trust Beliefs (for example, Bett, Houston, Steer

& Gardner, 2017; Rotenberg, 1994; Rotenberg, Macdonald & King, 2004; Qualter et al., 2013; Rotenberg et al., 2010; Rotenberg et al., 2014). Moreover, trust beliefs and loneliness predict each other reciprocally over time (Rotenberg et al., 2010), suggesting that it is an important affective factor of loneliness.

Furthermore, trust beliefs have a significant link with individual's social behaviour (Rotenberg, et al., 2014). Children with a higher level of trust beliefs are more likely to initiate prosocial behaviour (Chin, 2014; Malti et al., 2016), whereas adults who are primed by a distrust for social interaction show more withdrawal affect, less willingness to self-disclose, and report that they receive less support from others (Rotenberg, et al., 2010). Such withdrawal behaviour was found in lonely individuals (Weis et al., 2005), suggesting that trust beliefs may have a protective role in the association between loneliness and negative social behaviour.

Moreover, trust beliefs tend to have an effect on individuals' perceptions of social relationships. According to the mutual quality of trust, in a dyadic relationship, the level of trust level that one person has for to his/her partner will determine how the other person trusts him/her (Rotenberg, 1994). Individuals scoring high on the UCLA loneliness scale (Russell, 1978) are characterised by a negative attitude toward others in general, and believe that others will also view them negatively (Jones, et al., 1982). It is likely that such a negative link between loneliness and social cognition may be mediated by trust beliefs. However, these relations have not been fully examined in an adult sample. The current study aimed to fill this gap.

Moreover, most of the studies examining the effect of loneliness and trust beliefs include child samples. Amongst the findings from those child studies, the effect between trust beliefs and children are not only found in the low trust children but also high trusting children (Rotenberg et al., 2014): children with very low and very high trust beliefs show a different behavioural pattern from children in the middle range of trust beliefs. Most of the adult studies do not report similar findings (for example, Bett, et al., 2017; Rotenberg, 1994). Therefore, more research on how high lonely and low lonely adults differed in their level of trust beliefs is needed. The current study will examine this issue in a university student sample with two time points and will compare the ensuing results with previous studies.

Loneliness and trait Emotional Intelligence (EI). Emotional Intelligence (EI) is a concept describing a group of personal characteristics to identify and manage the emotions in oneself and others (Mayer, Salovey, & Caruso 1999). EI has been classified into two subfactors: the ability EI and the trait EI. Ability EI is defined by the cognitive ability to understand and use emotion on oneself and on others (Mayer & Salovey, 1997), whereas the trait EI is a relatively stable constellation of emotion-related definitions of self, that is located on the lower level of personality hierarchies (Petrides, et al., 2007).

Loneliness is negatively associated with both trait EI and ability EI (Joshi & Kang, 2015; Zhang, Zou, Wang & Finy, 2015; Wols, Scholte & Qualter, 2015; Zou, 2014; Zysberg, 2012). Moreover, the results of longitudinal studies of loneliness and ability EI suggest that better skills of understanding and use of emotions predict a reduction of loneliness level over time. Conversely, a higher level of loneliness predicts a decrease in the skills to understand and manage emotion over time (Wols, Scholte & Qualter, 2015). These findings suggest a causal link between loneliness and the understanding of emotions which may affect one's cognition and social perceptions. In fact, a study examining the mediator of the relationship between trait EI and loneliness found that both self-esteem and social support mediates the relationship respectively (Zou, 2014). In other words, individuals with a higher level trait EI could understand and manage emotion in order to improve their self-esteem, which in turn reduced the level of loneliness. In addition, individuals with a high score on the trait EI could receive more social support and reduce the level of loneliness.

The findings outlined in the foregoing suggest that loneliness is not only negatively associated with EI. A higher level of EI links to many cognitive aspects that protect individuals from developing and maintaining loneliness. Therefore, it is important to examine the relationship between loneliness and EI in the current study.

Loneliness and social desirability. Social desirability refers to the tendency of an individual to respond in a certain way or manner to make others perceive him/her in a positive light (van de Mortel, 2008). Loneliness is negatively correlated with social desirability among college and university students (Davis, 2004; Durak & Senol-Durak, 2010; Russell, 1996) and adults (M_{age} = 29.98) (Caputo, 2017).

Moreover, individuals with a lower level of social desirability are more likely to score a higher level of loneliness and depression (Fultz & Herzog, 2001). However, loneliness is positively correlated with social desirability in adolescence (Lasgaard, Goossens & Elklit, 2011), suggesting that the relationships between loneliness and social desirability may change through the stages of development.

Individuals with a higher level of loneliness scores are characterised by their negative perception of themselves and others (Christensen & Kashy, 1998; Tsai & Reis, 2009). It is likely that lonely individuals will have less intention to please others by holding these negatie intentions towards others. The current study will measure the association between loneliness and social desirability, it is hypothesised that loneliness will negatively correlate with social desirability in the current sample.

Hypotheses

For the current study, it is predicted that loneliness is positively correlated with depressive symptoms, fear of negative evaluation, and interaction anxiousness. Furthermore, I expected loneliness to be negatively correlated with trait emotional intelligence, social desirability, and trust beliefs.

Method

Participants and Procedures

A total of one hundred and twenty-five students at the University of Central Lancashire participated. They were recruited via flyers and campus-wide emails. Among the respondents, 95 participants were females, and 26 were males; 4 participants did not report their gender. The age range of the sample was between 18 and 54 years old (M = 22.26, SD = 7.13). Participants were invited to complete the same questionnaires again after 10 months. At Time 2 with 10 months apart from the first wave of data collection, 25 participants (19 females), with a mean age of 24.00 (SD = 7.57, range: 19-49) took part in the study again.

Participants responded via email or face to face if they expressed interest in taking part in the study. The study involved completing eight questionnaires. The questionnaires were completed online or on paper. Each participant signed the online or paper consent form before they took part in the study. Participants were informed that they had the right to stop participating at any time; for people completing the questionnaires online, there was a Panic Button to press on each online questionnaire page, to ensure participants could withdraw at any time. The study was approved by the ethic committee at the University of Central Lancashire.

The study involved completing eight questionnaires, including UCLA Loneliness Scale (Russell et al., 1980), Centre for Epidemiologic Studies Depression Scale (CES-D, Radloff, 1977), Brief fear of negative evaluation Scale (Leary, 1983), Interaction Anxiousness Scale (Leary, 1983), Trait Emotional Intelligence Questionnaire--- Short Form (TEIQue-SF) (Petrides & Furnham, 2006), Marlowe-Crowne Social Desirability Scale –13 items (Reynolds, 1982) and Rotter's Interpersonal Trust Scale (ITS, Rotter, 1967).

Materials

Revised UCLA loneliness scale (Russell et al., 1980). The UCLA Loneliness scale comprises 20-items for which participants were instructed to rate how often, on a likert scale, they thought a described behaviour was common of them. Each item of the scale describes an aspects of "one's subjective feelings of loneliness as well as feelings of social isolation." Responses were rated on a Likert

scale from 1 (Never) to 4 (Often). The score range of the questionnaire is 20 to 80. Higher scores indicate a higher level of loneliness. Example items include “No one really knows me well”, “I feel left out”, and “I am unhappy being so withdrawn”. Cronbach’s alpha for the scale in the current study was 0.88.

Centre for epidemiologic studies depression scale (CES-D, Radloff, 1977). The CES-D scale is a 20-item scale designed to measure depressive symptomatology in the general population (Radloff, 1977). Participants were expected to score each item based on how often they felt that way during the past week. Each item was rated on a Likert scale range from 0 (Rarely or none of the time [less than 1 day]) to 3 (Most or all of the time [5-7 days]). The range of scores for the questionnaire is 0 to 60. Higher scores suggest the presence of more depressive symptoms. Example items in this scale include: “I was bothered by things that usually don’t bother me”, “I felt that I could not shake off the blues even with help from my family or friends”. Cronbach’s alpha was 0.90 in the current study.

Brief fear of negative evaluation (Leary, 1983). The Brief Fear of Negative Evaluation is a 12-item scale that assesses the degree to which people are apprehensive about being evaluated negatively. Instructions of the scale asked subjects to indicate how characteristic each statement was as a description of them. Participants responded to each item using a 5-point Likert scale from 1 (Not at all characteristic of me) to 5 (Extremely characteristic of me). The score range for the questionnaire is 12 to 60. Higher scores on the scale indicate a higher tendency to be apprehensive at the prospect of being evaluated negatively (Leary, 1983). Example items in the scale include “I worry about what other people will think of me even when I know it doesn’t make any difference”, “I am afraid that others will not approve of me”. Cronbach’s alpha was 0.93 in the current study.

Interaction Anxiousness Scale (Leary, 1983). The Interaction Anxiousness Scale measures the general tendencies of participants to experience anxious feelings in situations involving contingent social interactions (Leary, 1983). The Interaction Anxiousness Scale consists of 15 items, each item was measured on a 5 point Likert scale from 1 (Not at all characteristic of me) to 5 (Extremely characteristic of me). The score range of the scale is 15 to 75. Higher scores on the Interaction Anxiousness Scale indicate a higher level of social anxiety. Example items include

"I often feel nervous even in casual get-togethers", "I wish I had more confidence in social situations", "I get nervous when I must talk to a teacher or boss". Cronbach's alpha was 0.87 in the current study.

Trait Emotional Intelligence Questionnaire--- Short Form (TEIQue-SF) (Petrides & Furnham, 2004). The TEIQue-SF is a 30-items scale measures global trait emotional intelligence (EI). The TEIQue-SF is a shortened version of the full form of the TEIQUE, which covers 15 distinct facets of global trait EI. Two items of each of the 15 facets were selected to be included in the short form. The scale uses a 7 point Likert scale for response option, ranging from 1 (Completely Disagree) to 7 (Completely Agree). Example items include "I usually find it difficult to regulate my emotions", "I normally find it difficult to keep myself motivated", "I tend to back down even if I know I'm right." A higher score indicates a higher trait EI. Cronbach's alpha for the scale in the current study is 0.85.

Marlowe-Crowne Social Desirability Scale –13 items (Reynolds, 1982). This 13 item scale measures the tendency of the respondent to answer the questions in a socially desirable way in order to make themselves looks good to match current social norms (Mick, 1996). Example items include socially desirable items such as "No matter who I'm talking to, I'm always a good listener" and socially undesirable items such as "It is sometimes hard for me to go on with my work if I am not encouraged". Participants give "True" or "False" answer to each statement. A higher score on the scale suggests that the individual tend to present a socially desirable image of themselves, but that they may not be giving an honest answer. Cronbach's alpha for the scale in the current study is .72.

Rotter's Interpersonal Trust Scale (ITS, Rotter, 1967). The ITS measures the degree of trust an individual attributes to the society and to different groups of people, for example, teachers, students, friends and so on. The scale uses a 5 point Likert scale ranging from 1-Strongly Agree to 5-Strongly Disagree. Examples of items include "Deceit is on the increase in our society", "Parents usually can be relied upon to keep their promises", "It is safe to believe that in spite of what people say, most people are basically interested in their own welfare". A higher score indicates a higher level of interpersonal trust, a lower score indicates less interpersonal trust. The Cronbach's alpha of the scale in the current study is 0.81.

Results

The average loneliness score of the 125 adults who took part in the research was 41.57 (*SD* = 10.01). 65 participants (52%) reported a loneliness level above the mean in the current sample, 17 participants (13.6%) scored 1 standard deviation above the mean (>51.58), 3 participants scored (2.4%) scored 2 standard deviations above the mean (>61.59), and 1 participant (0.8%) scored 3 standard deviations above the mean (>71.60). The distribution pattern of the loneliness score are in line with the probability of distribution and suggest participants in the current study represents a normal distribution of loneliness level.

Means and Standard Deviations between Measures of Time 1

The Table 7.1 presents the means, standard deviations, and reliability of all the questionnaires for participants. The mean score of the UCLA loneliness scale and the reliability of the scale is measured by Cronbach's alpha are in line with previous research findings amongst a student sample, which normatively reaches the mean of 40.08 (*SD* = 9.50), (Russell, 1996).

Table 7.1. *Descriptive statistics and Cronbach's alpha values at Time 1*

Note. *N*=125

Variables	*M*	*SD*	α
Loneliness	41.57	10.01	.88
Depressive Symptoms	18.19	10.66	.90
Emotional Intelligence	131.90	23.67	.85
Fear of Negative Evaluation	38.94	11.76	.93
Interaction Anxiousness	44.94	11.46	.87
Social Desirability	6.94	2.91	.72
Trust Beliefs	85.57	10.18	.81
Age	21.41	5.87	

Correlations between Measures of Time 1

To examine whether loneliness was associated with the other interpersonal difficulties, Bivariate Pearson's Correlations between these variables were conducted; findings are displayed in Table 7.2. The results showed that loneliness was positively correlated with Depression, Fear of Negative Evaluation, Interaction Anxiousness and Trust Beliefs. Loneliness is negatively correlated with Emotional Intelligence and Social Desirability. Age, however, was not correlated with loneliness in the current study.

The results suggested that loneliness is associated with more negative affect. The results demonstrated the hypotheses well, showing that individuals who experienced higher loneliness were more likely to experience depressive symptoms and social anxiety; those scoring higher on loneliness scored lower on the constructs that might help mitigate loneliness, such as the ability to understand and utilise emotion or being socially eager to give people a positive impression.

Table 7.2. *Correlation matrix of loneliness and other questionnaire measures at Time 1*

	1	2	3	4	5	6	7	8
1.Loneliness	_____							
2.Depressive Symptoms	.61***	_____						
3.Emotional Intelligence	-.51***	-.34***	_____					
4.Fear of Negative Evaluation	.33***	.33***	-.21*	_____				
5.Interaction Anxiousness	.51***	.40***	-.29**	.63***	_____			
6.Social Desirability	-.27**	-.24**	.22*	-.12	-.12	_____		
7.Trust Belief	.25**	.28**	-.02	.10	.26**	-.04	_____	
8.Age	-.16	-.25**	-.09	-.06	-.19*	.03	-.37***	_____
Mean	41.60	18.28	131.70	38.86	44.32	6.87	84.86	21.39
SD	10.06	10.46	23.24	11.71	12.18	2.97	12.78	5.85

Note. N=125, *p<.05, **p<.01, ***p<.001

Characteristic of the Sample of Time 2

Twenty-five university students from a North West university in the UK participated in the current study. The mean age of the sample was 24.00 (*SD* = 7.57), ranging between 19-49. Students were emailed after 10-month from Time Point 1. Participants were rewarded with study credits if they were Psychology students.

A total of 25 adults took part in the research, the average loneliness score of the sample was 38.08 (*SD* = 9.98), with 10 participants (40%) reporting a loneliness level above the mean in the current sample, the number of students scored above the means at T2 reduced 12% after 10-month time. 3 participants (12%) scored 1 standard deviation above the mean (>48.06), 1 participants (4%) scored 2 standard deviations above the mean (>58.04), no participant scored 3 standard deviations above the mean (>68.02). The distribution of loneliness is similar to the sample at Time 1.

Table 7.3 presents the means, standard deviations and reliability of all the questionnaire scores for participants at Time Point 2. The mean score of the UCLA loneliness scale was 38.08 (*SD* = 9.98), showing a slight decrease from Time 1. The mean of UCLA loneliness score of the 25 people at the second time point is 38.43 (*SD* = 10.30). There is a strong correlation of loneliness scores between the two time points of measure ($r = .69$, $p < .001$***), suggesting loneliness level is stable across the 10 months lag. A paired sample t-test was run between the loneliness level at the two time points, $t(22) = 2.28$, $p = .033$*, suggesting the decrease of loneliness score from Time 1 to Time 2 is statistically significant.

Table 7.3. *Descriptive statistics and Cronbach's alpha values at Time 2*

Variables	*M*	*SD*	α
Loneliness	38.08	9.98	.90
Depressive Symptoms	15.24	12.08	.93
Emotional Intelligence	142.56	26.47	.91
Fear of Negative Evaluation	40.16	11.13	.92
Interaction Anxiousness	43.12	10.03	.80
Social Desirability	7.00	2.71	.63
Trust Beliefs	79.52	13.47	.86
Age	24.00	7.57	

Note. *N* = 25

Correlations between Measures of Time Point 2

Table 7.4 below presents the correlation table of the studied variables at Time 2. The correlation between measures for Time 2 showed that loneliness is positively correlated to Depressive Symptoms, Fear of Negative Evaluation, and Interaction Anxiousness. Moreover, loneliness is negatively correlated with Emotional Intelligence. However, there were no significant results between Loneliness and Social Desirability, Trust Beliefs and Age. Comparing with Time 1, the correlation between loneliness and Depressive Symptoms, loneliness and Emotional Intelligence tend to be stable at Time 2. However, the correlation between loneliness and Trust Beliefs, loneliness and Social Desirability was not significant at Time 2. The effect between loneliness and Fear of Negative Evaluation increased from Time 1 to Time 2, and the effect between loneliness and Interaction Anxiousness decreased from Time 1 to Time 2. The results suggested that there are significant variations of correlations between loneliness and psychological constructs amongst university students, however, the effect needs to be treated with cautious because of the limited number of participants at Time 2.

Table 7.4. *Correlation matrix of loneliness and other questionnaire measures at T2*

	1	2	3	4	5	6	7	8
1.Loneliness	_____							
2.Depressive Symptoms	.55**	_____						
3.Emotional Intelligence	-.50*	-.49*	_____					
4.Fear of Negative Evaluation	.64**	.56**	-.55**	_____				
5.Interaction Anxiousness	.51**	.41*	-.54**	.73***	_____			
6.Social Desirability	-.25	-.22	.33	-.31	-.20	_____		
7.Trust Belief	.06	.47*	-.24	.36	.23	-.30	_____	
8.Age	.001	-.29	-.08	-.11	-.06	.36	-.48*	_____
Mean	38.08	15.24	142.56	40.16	43.12	7.00	79.52	24.00
SD	9.98	12.08	26.47	11.13	10.03	2.71	13.48	7.57

N=25, *p<.05, **p<.01, ***p<.001

Discussion

The current study examined whether loneliness correlated with other affective and social-emotional factors amongst university students. Loneliness was positively correlated with Depressive Symptoms, Fear of Negative Evaluation, Interaction Anxiousness, and Trust-Beliefs, but negatively correlated with Trait Emotional Intelligence and Social Desirability. The results suggest that the lonelier a person is, the less likely they are to demonstrate protective mechanisms that might mitigate loneliness, such as social desirability (a tendency to get other people to perceive them in a positive light) and trait EI (the ability to understand and manage emotion of oneself).

The results are in line with previous research findings, wherein empirical research has shown that loneliness is associated with many negative affective features, including depressive symptoms (Cacioppo, Hughes, Waite, Hawkley & Thisted, 2006; Jose & Lim, 2014; Vanhalst, Luyckx, Teppers & Goossens, 2012; Vanhalst et al., 2012), social anxiety (Chalise, Kai & Saito, 2010; Deckers, Muris & Reolofs, 2017; Mak, Fosco & Feinberg, 2018; Ren & Liu, 2017; Schulz, et al., 2015; Suveg, et al., 2017), Trust beliefs (Bett, et al., 2017; Rotenberg, 1994; Rotenberg, et al., 2004; Qualter et al., 2013; Rotenberg et al., 2010; Rotenberg et al., 2014), Emotional Intelligence (Joshi & Kang, 2015; Zhang, et al., 2015; Wols, et al.,2015; Zou, 2014; Zysberg, 2012), and Social Desirability (Durak & Senol-Durak, 2010; Russell, 1996). The results of the current study are in line with these results, suggesting that individuals with a higher level of loneliness scores showed the same correlation pattern with the previous literature.

However, the only different findings from the previous research were between loneliness and trust beliefs. Some studies found a negative relation between loneliness and trust beliefs (Bett, et al., 2017; Rotenberg, 1994), whereas in the current study, trust beliefs was only positively associated with loneliness at Time 1. In other words, lonely university students tended to be more trusting of others. This may be linked to a previous behavioural study which showed that lonely college students tend to see unfamiliar others in a more positive light, but see close others in a more negative light (Tsai & Reis, 2009). It is possible that university students tend to alleviate their feelings of loneliness by trusting unfamiliar others in the university and attempting to build new contacts with others.

Limitations and Future Directions

The current study is original in the longitudinal design that collected data across 2 time points in university students. However, it does not come without limitations. First of all, the number of participants in the current study is limited, with only 25 students took part at Time 2, it is difficult to generate conclusions of the changes of correlations level from Time 1.

Appendix 2 Ethics Approval of the Cognitive Study

17 October 2013

Pamela Qualter / Jingqi Yang

School of Psychology

University of Central Lancashire

Dear Pamela / Jingqi

Re: PSYSOC Ethics Committee Application

Unique Reference Number: **PSYSOC 113**

The PSYSOC ethics committee has granted approval of your proposal application '**Exploring the Cognitive Biases of Lonely People: A Social and Cognitive Approach**'.

Please note that approval is granted up to the end of project date or for 5 years, whichever is the longer. This is on the assumption that the project does not significantly change, in which case, you should check whether further ethical clearance is required

We shall e-mail you a copy of the end-of-project report form to complete within a month of the anticipated date of project completion you specified on your application form. This should be completed, within 3 months, to complete the ethics governance procedures or, alternatively, an amended end-of-project date forwarded to roffice@uclan.ac.uk quoting your unique reference number.

Yours sincerely

Cath Sullivan

Chair

PSYSOC Ethics Committee

NB - Ethical approval is contingent on any health and safety checklists having been completed, and necessary approvals as a result of gained.

Appendix 3. Ethics Approval of the Observation Study

22 November 2013

Gayle Brewer / Pam Qualter / Loren Abel / Jingqi Yang

School of Psychology

University of Central Lancashire

Dear Gayle / Pam / Loren / Jingqi

Re: PSYSOC Ethics Committee Application

Unique Reference Number: **PSYSOC 052_4th phase**

The PSYSOC ethics committee has granted approval of your proposal application '**Study One: An Observational Study of individual differences and Social Interaction within Stranger Dyads / Study Two: An Observational Study of Individual differences and Social Interaction within Friendship Dyads**'.

Please note that approval is granted up to the end of project date or for 5 years, whichever is the longer. This is on the assumption that the project does not significantly change, in which case, you should check whether further ethical clearance is required

We shall e-mail you a copy of the end-of-project report form to complete within a month of the anticipated date of project completion you specified on your application form. This should be completed, within 3 months, to complete the ethics governance procedures or, alternatively, an amended end-of-project date forwarded to roffice@uclan.ac.uk quoting your unique reference number.

Yours sincerely

Cath Sullivan

Chair

PSYSOC Ethics Committee

NB - Ethical approval is contingent on any health and safety checklists having been completed, and necessary approvals as a result of gained.

Appendix 4. Words' Valence, Concreteness, Number of Letters, Number of Syllables, and Written Frequencies in the Serial Recall Task

Social Threat words

No.	Word	Valence	Concreteness	K-freq	Letter	Syllable	T-freq
1	Hate	2.12	335	42	4	1	456
2	Tease	4.84		6	5	1	105
3	Coward	2.74		8	6	2	71
4	Insane	2.85		13	6	2	81
5	Stupid	2.31	351	24	6	2	144
6	Lonely	2.17		25	6	2	203
7	Neglect	2.63	282	12	7	2	192
8	Inferior	3.07	311	7	8	3	40

Social Positive words

No.	Word	Valence	Concreteness	K-freq	Letter	Syllable	T-freq
1	Hope	7.05	261	178	4	1	1180
2	Loyal	7.55		18	5	1	91
3	Admire	7.74	296	10	6	2	257
4	Engage	8.00(engaged)		14	6	2	424
5	Gentle	7.31	322	27	6	2	242
6	Virtue	6.22	243	30	6	2	126
7	Passion	8.13	300	28	7	2	236
8	Intimate	7.61	281	21	8	3	172

Physical Threat words

No.	Word	Valence	Concreteness	K-freq	Letter	Syllable	T-freq
1	Hurt	1.90	368	37	4	1	725
2	Pinch	3.83		6	5	1	86
3	Robber	2.61	545	2	6	2	27
4	Coffin	2.56	595	7	6	2	50
5	Cancer	1.50	615	25	6	2	27
6	Damage	3.05	406	33	6	2	156
7	Assault	2.03	410	15	7	2	46
8	Mutilate	1.82			8	3	8

Physical Positive words

No.	Word	Valence	Concreteness	K-freq	Letter	Syllable	T-freq
1	Safe	7.07	376	57	4	1	550
2	Greet	7.00		7	5	1	238
3	Cuddle	7.72			6	2	15
4	Dazzle	7.29		1	6	2	79
5	Lively	7.20		26	6	2	103
6	Secure	7.57		30	6	2	353
7	Protect	7.29 protected		34	7	2	383
8	Carefree	7.54		9	8	3	42

Neutral words

No.	Word	Valence	Concreteness	K-freq	Letter	Syllable	T-freq
1	Deer		631	13	4	1	47
2	Sheep		622	23	5	1	86
3	Badger			1	6	2	20
4	Turtle		644	8	6	2	21
5	Monkey		566	9	6	2	64
6	Rabbit	6.57	635	11	6	2	96
7	Hamster		599		7	2	
8	Elephant		628	7	8	3	144

Appendix 5 Words' valence, concreteness, number of letters, number of syllables, and written frequencies in the Emotional Stroop Task

Social Threat words

No.	Word	Valence	Concreteness	K-freq	Letter	Syllable	T-freq
1	Shy	4.64		13	3	1	139
2	Fear	2.76	326	127	4	1	711
3	Shame	2.05 Shamed	287	21	5	1	210
4	Jealous	2.51 jealousy		4	7	2	183
5	Hatred	1.98	239	20	6	2	98
6	Embarrass	3.03 embarrassed	249	16	9	3	103
7	Inferior	3.07	311	7	8	3	40
8	Neglect	2.63	282	12	7	2	192
9	Failure	1.70	282	89	7	2	262
10	Useless	2.13		17	7	3	129

Social Positive words

No.	Word	Valence	Concreteness	K-freq	Letter	Syllable	T-freq
1	Pal			2	3	1	
2	Love	8.73	311	232	4	1	5129
3	Brave	7.15	283	24	5	1	216

4	Beloved	8.64 Loved	356	18	7	2	95
5	Polite	7.18 Politeness	342	7	6	2	115
6	Confident	7.89		16	9	3	92
7	Passion	8.13	300	28	7	2	236
8	Intimate	7.61	281	21	8	3	172
9	Respect	7.64	280	125	7	2	349
10	Honesty	7.21 Honest	278	10	7	3	121

Physical Threat words

No.	Word	Valence	Concreteness	K-freq	Letter	Syllable	T-freq
1	Hit	4.33		115	3	1	420
2	Pain	2.13	426	88	4	1	541
3	Death	1.61	365	377	5	1	815
4	Torture	1.56	437	3	7	2	224
5	Brutal	2.90	420	7	6	2	54
6	Ambulance	2.47	595	6	9	3	90
7	Assault	2.03	410	15	7	2	46
8	Mutilate	1.82			8	3	8
9	Destroy	2.64	367	48	7	2	270
10	Funeral	1.39		33	7	3	129

Physical Positive words

No.	Word	Valence	Concreteness	K-freq	Letter	Syllable	T-freq
1	Hug	8.00		3	3	1	94
2	Free	8.26	328	260	4	1	777
3	Smile		514	58	5	1	2143
4	Glamour	6.76		5	7	2	55
5	Caress	7.84		1	6	2	75
6	Beautiful	7.60	393	127	9	3	987
7	Secure	7.57		30	6	2	353
8	Protect	7.29		34	7	2	383
9	Healing	7.09 heal		6	7	2	
10	Holiday	7.55	439	17	7	3	172

Neutral words

No.	Word	Valence	Concreteness	K-freq	Letter	Syllable	T-freq
1	Sun	7.55	617	112	3	1	603
2	Wind		552	63	4	1	657
3	Cloud		554	28	5	1	367
4	Monsoon		508	3	7	2	2
5	Winter		499	83	6	2	610
6	Temperate			2	9	3	12
7	Autumn	6.30	421	22	6	2	132
8	Climate			26	7	2	127
9	Thunder		547	14	7	2	138
10	Almanac			1	7	3	10

Appendix 6 Words' valence, concreteness, number of letters, number of syllables, and written frequencies in the Directed Forgetting Task

Neutral words

No.	Word	Valence	Concreteness	K-freq	Letter	Syllable	T-freq
1	Baker			36	5	2	86
2	Actor			24	5	2	240
3	Sailor			5	6	2	200
4	Farmer			23	6	2	519
5	Author		502	46	6	2	312
6	Lawyer		569	43	6	2	417
9	Waiter			10	6	2	156
10	Barber			8	6	2	50
7	Soldier		578	39	7	2	259
8	Teacher	5.68	569	80	7	2	356
13	Musician		564	23	8	3	72
14	Engineer		531	42	8	3	218
11	Professor		549	57	9	3	272
12	Athletics	6.61	437	9	9	3	22

Physical Positive words

No.	Word	Valence	Concreteness	K-freq	Letter	Syllable	T-freq
1	Relax	Relaxed(7.00)		19	5	2	193
2	Agile		356	2	5	2	15
3	Active			88	6	2	186
4	Talent	7.56	290	40	6	2	166
5	Wisdom		275	44	6	2	139
6	Decent			20	6	2	206
7	Clever		313	17	6	2	225
8	Rescue	7.70	373	15	6	22	105
9	Freedom	7.58	277	128	7	2	256
10	Embrace		449	13	7	2	114
11	Peaceful	7.72(peace)	360	26	8	3	88
12	Ambition	7.04	281	19	8	3	218
13	Affection	8.39	280	18	9	3	220
14	Intellect	6.82	254	5	9	3	30

Physical Threat words

No.	Word	Valence	Concreteness	K-freq	Letter	Syllable	T-freq
1	Ulcer	1.78	558	5	5	2	7
2	Vomit	2.06			5	2	10
3	Lethal			5	6	2	
4	Victim	2.18	467	27	6	2	205
5	Trauma	2.10		1	6	2	
6	Punish	2.22(punishment)	344	3	6	2	56
7	Bloody	2.90		8	6	2	40
8	Poison	1.98	527	10	6	2	158
9	Destroy	2.64	367	48	7	2	270
10	Illness	2.48		20	7	2	183
11	Cemetery	2.63		15	8	3	
12	Violence			46	8	3	81
13	Suffocate	1.56	391		9	3	31
14	Infection	1.66	468	8	9	3	54

Social Positive words

No.	Word	Valence	Concreteness	K-freq	Letter	Syllable	T-freq
1	Funny	8.37(fun)		41	5	2	428
2	Jolly	7.41		4	5	2	97
3	Humour	8.56	309	1	6	2	
4	Loving	8.72(love)		15	6	2	101
5	Mature			31	6	2	91
6	Humane	6.89	332	5	6	2	14
7	Reward	7.53	396	15	6	2	154
8	Honest	7.70		47	6	2	393
9	Justice	7.78	307	114	7	2	181
10	Respect	7.64	280	125	7	2	349
11	Grateful	7.37		25	8	3	194
12	Romantic	8.32		32	8	3	191
13	Impressed	7.33		30	9	3	
14	Dignified	7.10		7	9	3	70

Social Threat words

No.	Word	Valence	Concreteness	K-freq	Letter	Syllable	T-freq
1	Idiot	3.16		2	5	2	59
2	Tease	4.84		6	5	2	105
3	Reject	1.50(rejected)		10	6	2	51
4	Betray	1.68		4	6	2	112
5	Insult	2.29	375	7	6	2	101
6	Guilty	2.63		29	6	2	161
7	Offend	2.76	321	4	6	2	67
8	Deceit	2.90	257	2	6	2	26
9	Hostile	2.73		19	7	2	54
10	Failure	1.70	282	89	7	2	262
11	Immature	3.39		7	8	3	17
12	Ridicule	3.13	310	5	8	3	44
13	Ignorant			12	9	3	88
14	Obnoxious	3.50		5	9	3	9

Appendix 7 Words' valence, concreteness, number of letters, number of syllables, and written frequencies in the Recognition stage of the Directed Forgetting Task

Neutral words

No.	Word	Valence	Concreteness	K-freq	Letter	Syllable	T-freq
1	Pilot			44	5	2	184
2	Tutor			4	5	2	26
3	Banker		547	5	6	2	152
4	Singer		553	10	6	2	97
5	Doctor	5.20	575	100	6	2	1631
6	Tailor		535	2	6	2	134
7	Broker			1	6	2	90
8	Golfer	5.61		3	6	2	
9	Dentist	4.02	607	12	7	2	61
10	Butcher		556	8	7	2	55
11	Composer		487	31	8	3	21
12	Mechanic		580	5	8	3	84
13	Carpenter			6	9	3	74
14	Fisherman		567	5	9	3	70

Physical Positive words

No.	Word	Valence	Concreteness	K-freq	Letter	Syllable	T-freq
1	Witty			10	5	2	32
2	Alive	7.25		57	5	2	304
3	Dainty			3	6	2	106
4	Genius		342	23	6	2	156
5	Timely			9	6	2	27
6	Tender	6.93		11	6	2	333
7	Robust				6	2	24
8	Superb			14	6	2	49
9	Healthy	6.81 (health)		33	7	2	207
10	Prosper		356	3	7	2	19
11	Valuable			45	8	3	194
12	Abundant	6.59(Abundance)	351	9	8	3	50
13	Fortunate			22	9	3	136
14	Authentic		276	20	9	3	35

Physical Threat words

No.	Word	Valence	Concreteness	K-freq	Letter	Syllable	T-freq
1	Abuse	1.80		18	5	2	62
2	Fever	2.76	492	19	5	2	176
3	Crisis	2.74	319	82	6	2	116
4	Injure	2.49(injury)			6	2	122
5	Clinic			3	6	2	75
6	Deadly	1.94(dead)		19	6	2	129
7	Attack		411	105	6	2	339
8	Quiver		485		6	2	138
9	Exhaust		467	7	7	2	151
10	Painful	2.13(pain)		25	7	2	96
11	Homicide		385	6	8	3	18
12	Bacteria		560	8	8	3	19
13	Suffering			44	9	3	110
14	Abduction	2.76	337	1	9	3	

Social Positive words

No.	Word	Valence	Concreteness	K-freq	Letter	Syllable	T-freq
1	Amuse		321	3	5	2	205
2	Civil			91	5	2	150
3	Genial			5	6	2	22
4	Favour			2	6	2	
5	Plucky				6	2	9
6	Kindly	7.59(kind)		8	6	2	209
7	Humble	5.86	231	18	6	2	121
8	Mighty	6.54		29	6	2	241
9	Delight	8.26	282	29	7	2	353
10	Sincere			15	7	2	54
11	Sociable	social(6.88)		1	8	3	17
12	Tolerant		265	9	8	3	42
13	Competent			21	9	3	69
14	Outgoing			8	9	3	7

Social Threat words

No.	Word	Valence	Concreteness	K-freq	Letter	Syllable	T-freq
1	Timid	3.86		5	5	2	49
2	Inept			2	5	2	11
3	Feeble	3.26		8	6	2	42
4	Malice	2.69	248	2	6	2	32
5	Touchy			1	6	2	11
6	Ignore		320	19	6	2	193
7	Wicked	2.96		9	6	2	88
8	Menace	2.88	377	9	6	2	124
9	Fearful	2.25		13	7	2	70
10	Despair	2.43(despairing)	279	21	7	2	157
11	Jealousy	2.51	250	4	8	3	76
12	Peculiar			27	8	3	164
13	Depressed	1.83		11	9	3	30
14	Criticise			4	9	3	

Appendix 7 Correlations between Loneliness and Cognitive Task Performances at Time 1

7A Serial Recall task: Correlation table between loneliness and proportion of correct responses in each word categories at Time 1

Measure	1	2	3	4	5	6	7
1.Loneliness	____						
2.Silent	-.09	____					
3.Neutral	-.08	.72***	____				
4.Social Positive	-.05	.74***	.80***	____			
5. Physical Positive	-.01	.68***	.82***	.86***	____		
6. Social Threat	-.05	.76***	.84***	.87***	.88***	____	
7. Physical Threat	-.01	.73***	.82***	.90***	.87***	.89***	____

N=74, *p<.05, **p<.01, ***p<.001

Notes: Loneliness is not correlated with proportions of correct recall of digits for the Silent or Neutral and Valent conditions.

Appendix 7B Correlation Table of Loneliness and Reaction Time of Naming Each Category of Words and Number of Errors in the Emotional Stroop Task at Time 1

Measure	1	2	3	4	5	6	7	8	9	10	11	12
1.Loneliness	---											
2.Neutral	-.18	---										
3.Physical Positive	-.14	.97***	---									
4.Physical Threat	-.18	.97***	.96***	---								
5.Social Positive	-.14	.97***	.97**	.97***	---							
6.Social Threat	-.14	.97***	.96**	.96***	.97***	---						
7.Neutral Error	.35**	.03	.01	-.01	.02	.02	---					
8.Physical Positive Error	.25*	.03	.03	-.01	.02	.03	.36**	---				
9.Physical Threat Error	.15	.34**	.37**	.34**	.33**	.31**	.20	.47***	---			
10.Social Positive Error	.28*	-.09	-.12	-.15	-.11	-.10	.47***	.62***	.47***	---		
11.Social Threat Error	.06	.26*	.25*	.23	.23	.24*	.50***	.54***	.46***	.51***	---	
12.Total Error	.27*	.15	.14	.11	.13	.13	.65***	.77***	.69***	.83***	.82***	---

N=73, *p<.05, **p<.01, ***p<.001; *Note:* Loneliness is positively correlated with the number of errors made in naming the Neutral, Physical Positive, Social Positive words in the emotional Stroop task.

Appendix 7C Correlation Table of Loneliness and the Recall of Each Category of Remember and Forget Words in the Directed Forgetting task at Time 1

Measure	1	2	3	4	5	6	7	8	9	10	11
1.Loneliness	_____										
2.Neutral Remember	.06	_____									
3.Neutral Forget	.10	.18	_____								
4.Physical Threat Remember	.09	.24*	-.02	_____							
5.Physical Threat Forget	.06	.13	.24*	.13	_____						
6.Physical Positive Remember	.07	.33**	.24*	.42**	.17	_____					
7.Physical Positive Forget	.07	.11	-.08	-.18	-.11	-.02	_____				
8.Social Threat Remember	.21	.26*	.01	.31**	-.01	.18	-.05	_____			
9.Social Threat Forget	-.06	.18	.22	-.01	.13	.05	-.002	-.09	_____		
10.Social Positive Remember	-.01	.24*	.10	.23	.01	.49**	-.03	.29*	.06	_____	
11.Social Positive Forget	-.16	.01	-.02	.03	-.08	.15	-.17	.15	.10	-.04	_____

N=74, *p<.05, **p<.01, ***p<.001. *Note.* Loneliness is not correlated with the number of errors made in the recall of each category of Remember or Forget words in the Directed Forgeting task at Time 1.

Appendix 7D Correlation Table of Loneliness and the Recognition Accuracy (d') of Each Category of Remember and Forget Words in the Directed Forgetting Task at Time 1

Measure	1	2	3	4	5	6	7	8	9	10	11
1.Loneliness	_____										
2.Neutral Remember d'	.01	_____									
3. Physical Threat Remember d'	-.11	.54***	_____								
4. Physical Positive Remember d'	-.02	.58***	.45***	_____							
5. Social Threat Remember d'	.08	.53***	.38**	.38**	_____						
6. Social Positive Remember d'	.03	.40***	.32**	.39**	.40***	_____					
7. Neutral Forget d'	-.13	.57***	.20	.39**	.28*	.36**	_____				
8. Physical Threat Forget d'	-.04	.39**	.55***	.34**	.30**	.37**	.24*	_____			
9. Physical Positive Forget d'	.000	.44***	.34**	.67***	.39**	.31**	.29*	.30**	_____		
10. Social Threat Forget d'	-.12	.36**	.40***	.20	.64***	.40**	.15	.25*	.17	_____	
11.Social Positive Forget d'	.08	.15	.20	.15	.09	.62***	.32**	.26*	.14	.18	_____

N=74, **p*<.05, ***p*<.01, ****p*<.001. *Note.* Loneliness is not correlated with the recognition accuracy of each category of words followed by an Remember Instruction or an Forget Instruction.

Appendix 7E Correlation Table of Loneliness and the Recognition Bias (c') of Each Category of Remember and Forget Words in the Directed Forgetting Task at Time 1

Measure	1	2	3	4	5	6	7	8	9	10	11
1.Loneliness	_____										
2.Neutral Remember c'	-.21	_____									
3. Physical Threat Remember c'	-.02	.39**	_____								
4. Physical Positive Remember c'	.11	.41***	.36**	_____							
5. Social Threat Remember c'	-.24*	.44***	.47***	.51***	_____						
6. Social Positive Remember c'	-.01	.34**	.26*	.36**	.36**	_____					
7. Neutral Forget c'	-.11	.67***	.30**	.50***	.53***	.27*	_____				
8. Physical Threat Forget c'	-.09	.43***	.65***	.54***	.69***	.45***	.57***	_____			
9. Physical Positive Forget c'	.07	.40***	.39**	.76***	.53***	.40***	.56***	.62***	_____		
10. Social Threat Forget c'	-.07	.38**	.48***	.56***	.76***	.27*	.55***	.66***	.57***	_____	
11.Social Positive Forget c'	-.05	.37**	.38**	.43***	.56***	.66***	.49***	.59***	.55***	.47***	_____

N=74, **p*<.05, ***p*<.01, ****p*<.001. *Note.* Loneliness is negatively correlated with the recognition bias of Social Threat Remember words, suggesting individuals with a higher level of loneliness tend to say "Yes" to the Social Threat Remember words.

Appendix 7F Correlation Table of Loneliness and the Tagging Accuracy of Each Category of Remember and Forget Words in the Directed Forgetting Task at Time 1

Measure	1	2	3	4	5	6	7	8	9	10	11
1.Loneliness	_____										
2.Neutral Remember Hit	.06	_____									
3. Physical Positive Remember Hit	-.02	.39**	_____								
4. Physical Threat Remember Hit	-.13	.21	.35**	_____							
5. Social Positive Remember Hit	-.02	.44***	.38**	.28*	_____						
6. Social Threat Remember Hit	.14	.26*	.22	.44***	.32**	_____					
7. Neutral Forget Hit	-.08	-.16	.04	.11	.05	.12	_____				
8. Physical Positive Forget Hit	.15	.27*	.09	.21	.04	.31**	.33**	_____			
9. Physical Threat Forget Hit	-.09	.03	.09	.15	.09	-.01	.50***	.47***	_____		
10. Social Positive Forget Hit	.02	.28*	.09	.23	.12	.30**	.33**	.64***	.37**	_____	
11. Social Threat Forget Hit	.004	.19	.14	-.02	.07	.08	.37**	.44***	.49***	.41***	_____

N=74, *p<.05, **p<.01, ***p<.001. *Note.* Loneliness is not significantly correlated with tagging accuracy of any category of words followed by Remember ir Forget words in the Directed Forgetting task.

Appendix 8 Correlations between Loneliness and the Cognitive Task Performances at Time 2

8A Correlation Table of Loneliness and the Proportion of Correct Recall of Digits in Silent, Neutral or Valent Background Sounds at Time 2

Measure	1	2	3	4	5	6	7
1.Loneliness	____						
2.Silent	.46*	____					
3.Neutral	.30	.74***	____				
4.Social Positive	.30	.68***	.92***	____			
5. Physical Positive	.35	.76***	.90***	.90***	____		
6. Social Threat	.33	.72***	.92***	.90***	.93***	____	
7. Physical Threat	.44*	.64**	.78***	.90***	.82***	.81***	____

N=21, *p<.05, **p<.01, ***p<.001. Note. Loneliness is positively correlated with the Serial Recall performances in the Silent condtion.

Appendix 8B Correlation Table of Loneliness and the Reaction Time of Naming Each Category of Words, as well as the Number of Errors in the Emotional Stroop Task at Time 2

Measure	1	2	3	4	5	6	7	8	9	10	11	12
1.Loneliness	---											
2.Neutral	.10	---										
3.Physical Positive	.07	.98***	---									
4.Physical Threat	.02	.98***	.97***	---								
5.Social Positive	.01	.98***	.98***	.98***	---							
6.Social Threat	.08	.98***	.98***	.98***	.99***	---						
7.Neutral Error	.24	.29	.35	.37	.33	.36	---					
8.Physical Positive Error	.08	.27	.19	.33	.26	.22	.06	---				
9.Physical Threat Error	.20	.30	.28	.19	.24	.27	.14	-.21	---			
10.Social Positive Error	.52*	.60**	.61**	.50*	.52*	.57**	.46*	-.12	.55*	---		
11.Social Threat Error	.69**	.23	.16	.13	.11	.15	.25	.25	.33	.69**	---	
12.Total Error	.54*	.56*	.53*	.51*	.49*	.53*	.64**	.32	.57**	.83***	.78***	---

N=20, *p<.05, **p<.01, ***p<.001. *Note.* Loneliness is positively correlated with the colour naming errors of Social Postive and Social Threat words in the emotional Stroop task.

Appendix 8C Correlation Table of Loneliness and the Recall of Each Category of Remember and Forget Words in the Directed Forgetting Task at Time 2

Measure	1	2	3	4	5	6	7	8	9	10	11
1.Loneliness	_____										
2.Neutral Remember	.15	_____									
3.Neutral Forget	.19	.44*	_____								
4.Physical Threat Remember	.22	.29	.43*	_____							
5.Physical Threat Forget	.34	.52*	.53**	.50*	_____						
6.Physical Positive Remember	.11	.44*	.37	.49*	.76**	_____					
7.Physical Positive Forget	-.33	.007	.15	.30	.16	-.03	_____				
8.Social Threat Remember	.40	.52*	.24	-.002	.37	.52*	-.35	_____			
9.Social Threat Forget	.03	-.15	-.21	.03	-.03	-.03	.07	-.20	_____		
10.Social Positive Remember	.35	.40	.32	.27	.43*	.52*	-.19	.52*	.37	_____	
11.Social Positive Forget	.09	.34	.15	-.17	.16	.11	-.21	.49*	-.09	.36	_____

N=23, *p<.05, **p<.01, ***p<.001. *Note.* Loneliness is not positively correlated with the recognition accuracy of each word category followed by the Remember or Forget Intruction in the Directed Forgetting task at Time 2.

Appendix 8D Correlation Table of Loneliness and the Recognition Accuracy of Each Category of Remember and Forget Words in the Directed Forgetting Task at Time 2

Measure	1	2	3	4	5	6	7	8	9	10	11
1.Loneliness	_____										
2.Neutral Remember d'	.12	_____									
3. Physical Threat Remember d'	.32	.40	_____								
4. Physical Positive Remember d'	.10	.47*	.46*	_____							
5. Social Threat Remember d'	.01	.22	.31	.32	_____						
6. Social Positive Remember d'	.20	.46*	.41	.54*	.06	_____					
7. Neutral Forget d'	.30	.40	.16	.46*	.28	.37	_____				
8. Physical Threat Forget d'	.24	.47*	.37	.32	.60**	.01	.45*	_____			
9. Physical Positive Forget d'	.23	.62**	.24	.36	-.01	.37	.78***	.37	_____		
10. Social Threat Forget d'	.21	.08	-.28	.08	-.003	-.15	.12	.01	.03	_____	
11.Social Positive Forget d'	.03	.15	.08	-.13	.18	.01	-.07	.21	.10	.02	_____

N=23, **p*<.05, ***p*<.01, ****p*<.001. *Note.* Loneliness is not positively correlated with the recognition accuracy of each category of words followed by a Remember or Forget indtruction in the Directed Forgetting task at Time 2.

Appendix 8E Correlation Table of Loneliness and the Recognition Bias (c') of Each Category of Remember and Forget Words in the Directed Forgetting Task at Time 2

Measure	1	2	3	4	5	6	7	8	9	10	11
1.Loneliness	_____										
2.Neutral Remember c'	.12	_____									
3. Physical Threat Remember c'	.02	.58**	_____								
4. Physical Positive Remember c'	.30	.24	.52*	_____							
5. Social Threat Remember c'	-.21	.50*	.72***	.32	_____						
6. Social Positive Remember c'	.21	.33	.37	.52*	.22	_____					
7. Neutral Forget c'	.29	.32	.10	.36	-.13	.60**	_____				
8. Physical Threat Forget c'	-.15	.15	.56*	.28	.51*	.30	.02	_____			
9. Physical Positive Forget c'	.23	.55*	.33	.52*	.12	.47*	.50*	.02	_____		
10. Social Threat Forget c'	-.11	-.08	.33	.53*	.41	.52*	.01	.69**	.17	_____	
11.Social Positive Forget c'	.09	.30	.31	.55*	.22	.47*	.57**	.20	.41	.29	_____

N=23, *p<.05, **p<.01, ***p<.001. Note. Loneliness is not positively correlated with the recognition biases of each word category of words followed by a Remember or Forget instruction in the Directed Forgetting task at Time 2.

Appendix 8F Correlation Table of Loneliness and the Tagging Accuracy of Each Category of Remember and Forget Words in the Directed Forgetting Task at Time 2

Measure	1	2	3	4	5	6	7	8	9	10	11
1.Loneliness	_____										
2.Neutral Remember Hit	-.34	_____									
3. Physical Positive Remember Hit	-.28	.24	_____								
4. Physical Threat Remember Hit	.001	.27	.17	_____							
5. Social Positive Remember Hit	.15	.22	.40	.42	_____						
6. Social Threat Remember Hit	-.03	.23	.25	.32	.11	_____					
7. Neutral Forget Hit	.31	-.35	-.21	-.11	-.21	.01	_____				
8. Physical Positive Forget Hit	.08	-.09	.05	-.36	-.64**	-.07	.28	_____			
9. Physical Threat Forget Hit	.32	.14	-.26	-.30	-.43	.12	.28	.47*	_____		
10. Social Positive Forget Hit	.25	.17	-.25	.02	-.48*	.34	.42	.35	.58**	_____	
11. Social Threat Forget Hit	.27	.07	-.13	-.17	-.24	-.01	.44*	.27	.24	.76***	_____

N=23, **p*<.05, ***p*<.01, ****p*<.001. *Note.* Loneliness is not positively correlated with the tagging accuracy of each category of words followed by a Remember or Forget Instruction in the Directed Forgetting task at Time 2.

Appendix 9A Information Sheet of the Cognitive Study

PARTICIPANT INFORMATION SHEET

The Effects of how interpersonal relationships influence your perceptions of social information

My name is Jingqi Yang. I am a PhD student supervised by Dr. Pamela Qualter in the School of Psychology. I am conducting research into how interpersonal relationships affect people's processing of social information. I am interested in the impact of social anxiety, trait anxiety, trust beliefs, loneliness, emotional intelligence, depression and social desirability on a person's attention and memory of social information.

WHAT WILL HAPPEN

If you agree to take part, you will need to sign the consent form. Then you will be invited to complete 7 short questionnaires that measure loneliness, trust belief, depression, social anxiety, emotional intelligence, trait anxiety and social desirability. These questionnaires all include self-rating questions and use rating scales; each contains around 20 items. Completion of all 7 questionnaires will take you approximately 20 minutes. Completion of the questionnaires can be done online or by hand. If you choose to complete the questionnaires online, please follow the link at the end of the document; you will re-access the information sheet and you will be directed to the questionnaire page after you sign the consent form; if you would like to complete paper versions of the questionnaire, please contact me via email and I will invite you to the lab where you can complete the questionnaires; alternatively, you can take a questionnaire pack away today and return it to me to my office (Darwin building DB134).

After completing the questionnaire, you may be invited to the lab to complete some experimental tasks. If so, you will be asked to attend 1 session to complete 3 computer based tasks, include 2 attention tasks and 1 memory task. The tasks mainly involve your perception of different sets of (social) words. To complete all the tasks will take around 1 hour and 15 minutes.

If you decide to take part, please return the consent form to me no later than **30th March 2015.**

EXCLUSION CRITERIA

You need to have English as their first language because the tasks will involve reading and listening to words. You also need to have normal or corrected to normal vision and normal hearing.

PARTICIPANTS' RIGHTS

You may decide to stop being a part of the research study at any time without explanation. If you decide to stop participating in this study, we will no longer retain your personal data (i.e., contact details and names). If you have provided questionnaire and experimental task data, we will still retain that data unless you tell us you want to withdraw them too. If you choose to withdraw from the study, please inform us of whether you want to withdraw (1) your contact details, or (2) your contact details and your data. You cannot withdraw your data 12 months after the study has finished because all the data will have been anonymised and your personal information will be deleted at that point.

You have the right to omit or refuse to answer or respond to any question that is asked of you. You have the right to ask questions about the procedures. If you have any questions as a result of reading this information sheet, you should ask the researcher before the study begins.

COST, REIMBURSEMENT AND COMPENSATION

Your participation in this study is voluntary. If you are a Psychology student, you will receive 12 SONA points if you complete the whole research. If you decide to withdraw in the middle of the study, you will still be given SONA points for the previous stages. All participants will get a £5 voucher for their participation in the second stage of this study. All participants will also have an opportunity to win a £50 shopping voucher as a raffle prize. To do this, you will need to provide your personal details on the prize draw page (if complete the questionnaire on-line online) or complete the draw page in your questionnaire pack (if completed questionnaire by hand) and submit it to the submission box for this project in the Psychology Office (Darwin Building 120). I will be in touch via email if you win the prize after the whole study is finished. Your personal details provided for the draw will be stored in secure computer database or safely locked university cabinet and can only be accessed by authorised individuals. The information you provide for the prize draw will be kept separately from the other information for the current study and will be deleted from the database/shredded after the prize-winner has been drawn.

RISK AND BENEFITS

The questionnaires and tests used in this study are not sufficient for clinical decision so they are not used for diagnose purpose. Because the study involves materials about unpleasant personal feelings, participation in this study might make you feel upset, but

they should not be too distressing. In the event of any distress or need for emotional support, participants should follow up the suggestions of support services. There is a list of helpful organisations that are included on the 'debrief' sheet on the questionnaire pack. That sheet will be given to everyone who takes part in the research.

Should you have comments about the study that you wish to discuss with the researchers, please contact them using their contact details below.

CONFIDENTIALITY/ANONYMITY

Your personal data and questionnaire data will be stored in a safely locked university cabinet (if you completed the paper questionnaire pack) or on an authorised university computer (if you completed the questionnaire pack online); your scored questionnaire and task data will be safely stored on a university database on a secure computer, which can only be accessed by authorised individuals (myself and my supervisory team). You will be assigned a participant number when I input your questionnaire data and your task results into the computer. Your participant number and your personal data (name, email address) will be saved in separate files.

During the experimental/lab phase of the project, participants are invited back in 2 occasions with a week in between and email contact is necessary to confirm date and time. In the final task session, you will also be asked if you would like to be invited back to complete the research again in six months time. If you choose to come back after six months, you should be aware that I will keep your personal information through-out that period so that I have contact details. As mentioned before, all your personal data will be protected and only accessed by myself and other authorised

individuals (my supervisors). Your personal data are not used for other purposes and the data included in the final data-file does not contain any personal information.

If you decide to stop participating in this study, your name and contact details will be removed from the personal information file. Your anonymised questionnaire and experimental task data will still be retained and used in the analyses unless you explicitly ask us to withdraw them. You should contact us via email if you decide you want to withdraw from the study. Please be explicit about what you wish to withdraw: (1) your contact details, or (2) your contact details and your data.

If you complete the whole study (questionnaires and tasks at both time points) after 12 months of the completion, your name and contact details will be deleted from the system and your identity will not be recognisable in any form of report or publication. No one will link the data you provided to the identifying personal information you supplied. Only the researcher, the supervisory team, and other authorised individuals will have access to your personal data and only group results (not individual results) will be reported in my thesis. Results may appear eventually in a publication, but, again, this will look only at group results. You cannot withdraw your data 12 months after the study has finished because all the data has been anonymised and your personal information is deleted.

FOR FURTHER INFORMATION

If you would like to participate in this study online, please follow the link http://www.surveygizmo.com/s3/1404235/Interpersonal-relationship. You will find

the information sheet and consent form to complete at this link; the questionnaire follows that consent form.

If you would like additional information about the study please feel free to contact me and my supervisor.

Thank you.

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Appendix 9B Experiment Task Briefing Sheet of the Cognitive Study

Emotional stroop: in this task, you will see 200 different words flash in the centre of a white screen. The words will be presented with different colours. You will be asked to name the colour of the words as soon as possible regardless of the meaning of the words. There will be a 5 word practice session at the beginning of the session to get you familiar with the task.

Serial recall: in this task, there will be 8 digits (1 to 8) that flashing up in the centre of the screen in random sequence. You should try to remember the sequence of the numbers while either hearing a stream of words pronounced in the headphones or no sound at all.

Directed forgetting: you will see a word flashed in the centre of the screen, followed either by FFFFFF or RRRRRR. RRRRRR means remember the words and FFFFFF means forget the words. Altogether there will be 70 words presented in total. You will be asked to recall all the RRRRRR cue word after all the words have been presented.

Your task data will be safely stored on a university database on a secure computer, which can only be accessed by authorised individuals (myself and my supervisory team). You will be assigned a participant number when I input your questionnaire data and your task results into the computer. Your participant number and your personal data (name, email address) will be saved in separate files.

As previously mentioned, your participation is entirely voluntary and you have the right to withdraw your participation at anytime. If you decide to do so, your contact details and name will be removed from the system although your questionnaire scores and other test results will be retained anonymously unless you request that they are also removed. To withdraw your contact details and/or data, you can email me. You do not need to provide the reason(s) for withdrawal. Thanks for your participation.

If you complete the whole study (questionnaires and tasks at both time points) after 12 months of the completion, your name and contact details will be deleted from the system and your identity will not be recognisable in any form of report or publication. No one will link the data you provided to the identifying personal information you supplied. Only the researcher, the supervisory team, and other authorised individuals will have access to your personal data and only group results (not individual results) will be reported in my thesis. Results may appear eventually in a publication, but, again, this will look only at group results. You cannot withdraw your data 12 months after the study has finished because all the data has been anonymised and your personal information is deleted.

If you have any questions about the study please do not hesitate to contact me and my supervisor. In the event of any distress or need for emotional support, please follow up the suggestions of support services on the back of this sheet.

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Support and further information

The questionnaires and tests used in this study are not sufficient for clinical decision so they are not used for diagnose purpose. However, if any emotional difficulties or wellbeing worries were raise during the study, there are support mechanisms and the mental health helplines below that you might find it helpful:

Samaritans

Samaritans is a confidential and non-judgemental helpline provides emotional support, open 24 hours a day, 365 days a year.

Website: http://www.samaritans.org/

Telephone: 08457 90 90 90 (UK)

Email: jo@samaritans.org

MIND

MIND will provide advice and support to people who have mental health concerns and queries.

Website: http://www.mind.org.uk/

Telephone: 0300 123 3393

UCLan Counselling service

UCLan also offers a free, confidential counselling service to all students, if you would like to speak to a trained professional, please find the contact details of this service below:

Foster building 119 (first floor)

Telephone: 01772892572

Email: CoRecep@uclan.ac.uk

Appendix 9C Debriefing Sheet of the Cognitive Study

Debriefing sheet

Thank you for giving your time to take part in my project.

The 3 tasks you have participated in are designed to test if people's attention and memory particularly favour negative social information.

There are 5 different sets of words used in these tasks: neutral, social threat, social positive, physical threat and physical positive (See below). I am looking at whether you are particularly sensitive to social threat words compared to other categories in 3 different tasks.

In the whole study, I am looking at whether this bias has been influenced by the quality of their interpersonal and intrapersonal relationships. This is measured by the previous questionnaires (depression, anxiety, social desirability, emotional intelligence, social anxiety, loneliness, trust belief) you filled in at the beginning and end of the study.

Words example:

Social threat	social positive	physical threat	physical positive	neutral
Insane	engage	coffin	dazzle	turtle
Failure	respect	destroy	embrace	hammock
Jealousy	romantic	violence	ambition	composer
Fear	love	pain	free	wind

Emotional stroop task: the aim of this task was to explore people's attention when distinguishing 2 different kinds of information, the colour and the word. The longer time participants take to recognise the colour, the more easily they are distracted by the

information presented. In this task, your reaction time of each word was recorded and I will compare your reaction time between negative words and positive words.

Serial recall task: this task was intended to test if the social threat words in a stream of other words would impact one's attention and leads to poorer performance in remember the sequence of the number. Your time and corrected sequence were recorded.

Directed forgetting: in this task, I was interested in whether people found it difficult to forget social threat information even when they had been told to forget. The number of words remembered was recorded to identify what type of information was more appeal to people.

Just to remind you that you have the right to withdraw your participation. If you decide to do so, your contact details and name will be removed from the system. Your test data will be anonymised and retained, unless you explicitly ask us to withdraw them as well. You can tell me now if you want to do this, or you can contact me after this session via email.

Unfortunately, you will not be able to withdraw your personal data 12 months after the completion of the study because we will have deleted your personal data from the system. If this experiment has caused you distress or made you feel uncomfortable in any way, there is a list of helpline and support services in the support and further information sheet. Please get in touch if you feel the need to.

Thanks again for your participation. For any further information on the topic or other information and queries, please feel free to contact me or my supervisor using the following details:

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Support and further information

The questionnaires and tests used in this study are not sufficient for clinical decision so they are not used for diagnose purpose. However, if any emotional difficulties or wellbeing worries were raise during the study, there are support mechanisms and the mental health helplines below that you might find it helpful:

Samaritans

Samaritans is a confidential and non-judgemental helpline provides emotional support, open 24 hours a day, 365 days a year.

Website: http://www.samaritans.org/

Telephone: 08457 90 90 90 (UK)

Email: jo@samaritans.org

MIND

MIND will provide advice and support to people who have mental health concerns and queries.

Website: http://www.mind.org.uk/

Telephone: 0300 123 3393

UCLan Counselling service

UCLan also offers a free, confidential counselling service to all students, if you would like to speak to a trained professional, please find the contact details of this service below:

Foster building 119 (first floor)

Telephone: 01772892572

Email: CoRecep@uclan.ac.uk

Appendix 10 APIM Results of Loneliness and the Interactive Behaviour of Individuals in a Friendship less than 12 Months

	Actor β	Sig.	Partner β	Sig.	C2	Sig.
Successful Interruption	-.24	.007**	-.01	.888	.14	.252
Looking at Friend's Non-Face	-.18	.049*	.06	.489	.13	.267
Sighing	-.22	.011*	.25	.004**	.24	.044*

Notes: c1 = concurrent correlation between person 1's loneliness and person 2's loneliness levels; loneliness is correlated the same for all behaviour, correlation is .50 and significant ($p < .001$); actor = the influence of one's loneliness on their own behaviour; partner = the influence of one's loneliness on their partner's behaviour; c2 = concurrent correlation between one person's behaviour and their partner's behaviour. One hundred and twelve participants provided data in this study.

Appendix 11 APIM Results of Loneliness and Interactive Behaviour of Individuals in a Friendship Longer than 12 Months

	Actor β	Sig.	Partner β	Sig.	C2	Sig.
Gossip	-.34	.003**	-.15	.194	.62	.002**
Successful Interruption	.27	.019*	-.12	.326	-.05	.771
No Back Channel	.39	.000***	-.02	.864	.04	.819
Looking at Friend's Non-Face	-.27	.021*	-.26	.027*	.02	.932
Looking at Self	-.33	.004**	-.11	.341	.14	.443
Looking at Environment	.20	.084	.24	.041*	-.08	.646
Pouting	.09	.446	.27	.022*	-.20	.264
Head Nod	-.04	.770	.26	.033*	.39	.037*

Notes: c1 = concurrent correlation between person 1's loneliness and person 2's loneliness levels; loneliness is correlated the same for all behaviour, correlation is -.06 and not significant (p = .737); actor = the influence of one's loneliness on their own behaviour; partner = the influence of one's loneliness on their partner's behaviour; c2 = concurrent correlation between one person's behaviour and their partner's behaviour. One hundred and twelve participants provided data in this study.

Appendix 12 APIM results of the actor and partner effects of loneliness on post-interaction questionnaire rating in the long friendship group and short friendship group

	Actor effect β Short Friendship Group	**Partner effect β Short Friendship Group**	**Actor effect β Long Friendship Group**	**Partner effect β Long Friendship Group**
Quality	-.22(*p*=.002**)	-.20(*p*=.006**)	×	×
Disclosure	×	×	×	×
Engagement	.24(*p*=.005**)	×	×	×
Intimacy	×	-.22(*p*=.011*)	×	.28(*p*=.021*)
Self-view	-.29(*p*<.001***)	×	×	×
View of other	×	×	×	.30(*p*=.012*)
Other's view	-.28(p<.001***)	-.16(*p*=.049*)	×	×
Other's self-view	-.35(*p*<.001***)	×	×	×
Companionship	-.19(*p*=.014*)	-.22(*p*=.003**)	×	×
Help	×	-.19(*p*=.022*)	×	×
Intimacy	×	×	×	×
Reliable alliance	-.22(*p*=.007**)	×	×	×
Self-validation	×	-.23(*p*=.004**)	×	×
Emotional Security	-.22(*p*=.007**)	×	×	×

Appendix 13 Correlation table of loneliness and social behaviour in the observation study

Measure	1	2	3	4	5	6	7	8	9	10
1.Loneliness	_____									
2.Elaboration questions	-.01	_____								
3.Open-ended Questions	.06	.24**	_____							
4.Sighing	-.05	.20*	.11	_____						
5.Pouting and Sulking	-.01	.12	.01	.20*	_____					
6.No Back Channel	.16	-.01	-.02	.13	-.09	_____				
7. Successful Interruption	-.08	.08	-.003	.06	.18	.07	_____			
8.Unsuccessful Interruption	.10	.06	-.07	.07	.04	.03	.36***	_____		
9.Head Nod	-.02	-.24*	-.22*	-.02	.07	-.14	-.002	.20*	_____	
10.Uh Huh	-.02	.08	-.03	.13	-.01	.10	.04	.05	.16	_____

N=112, *p<.05, **p<.01, ***p<.001. *Note.* Loneliness is not significantly correlated with any social behaviours.

Appendix 14 Recruitment Advertisement of the Cognitive Study

Are you interested in how interpersonal relationships influence your perceptions of social information?

Are you between age 18 to 21?

Do you want to win £50 worth of shopping vouchers?

We would like you to take part in an online questionnaire (link) that asks you for information about your views of your friendships and beliefs about others' intentions in these relationships. If you agree to participate, you will be given 7 short questionnaires (about loneliness, trust belief, depression, social anxiety, emotional intelligence, trait anxiety and social desirability), each containing 20 items. In total the questionnaires will take 30 minutes to complete.

You may then be invited to come back to complete 3 computer based tasks (2 attention tasks and 1 memory tasks. These will involve processing different streams of words; The tasks will be completed during two sessions, a week apart.

You may then be invited back to re-run the study in 6 months' time as part of a larger study.

You will receive 6 course credit by completing the project if you are a psychology student and you will have a chance of winning a £50 worth shopping voucher as a raffle prize.

Exclusion criteria: participate in this study need to have English as their first language, you also need to have normal or corrected vision and normal hearing.

If you would like more information or have any questions please contact Jingqi Yang or Dr. Pamela Qualter.

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Appendix 15 AU Lookout Recruitment Advertisement of the Cognitvie Study

Would you like to take part in a PhD study, help contribute to understand how people processing social words and enter into a prize draw contain £50 shopping voucher?

If you would like to participate, you will be invite to complete some questionnaires (will take around 20 minutes) and you will also be invited to complete 3 computer based tasks (will take around 1 hour).

If you complete the whole study, you will have a chance of winning a £50 worth shopping voucher as a raffle prize. Psychology students will also be awarded 6 SONA participation credits.

You need to have English as your first language and you also need to have normal or corrected to normal vision and normal hearing.

If you would like to participate or want more information, please email Jingqi Yang (JYang10@uclan.ac.uk).

Thank you very much for your help!

Appendix 16 Recruitment Advertisement of Observation Study

Female Participants Wanted!!

Are you interested in how personality traits influence your perceptions of friendship?

Do you want to gain 6 SONA points?

If so, please come along to our research!

If you would like to participate, we will give you four questions about friendships to discuss with a close friend for 15 minutes.

We will film your chat because we are interested in your behaviour during the discussion. All your video footage will be saved in secure university computers and only accessed by the authorised individuals (e.g. researchers and research supervisors).

If you agree to take part, you will also be given some questionnaires asking about how you feel about the interaction and some personality traits that we are interested in. Each of you will fill the questionnaires independently. To complete all the questionnaires will take you 20 to 30 minutes.

Exclusion criteria: Participants must be **female**. To participate in this study need to have English as your first language.

If you would like to take part, just simply email to LAbell@uclan.ac.uk/JYang10@uclan.ac.uk and we can work out a time work for both of us.

If you would like more information or have any questions please contact Loren Abell or Jingqi Yang.

Social interactions study Labell@uclan.ac.uk

Social interactions study Jyang10@uclan.ac.uk

Social interactions study Labell@uclan.ac.uk

Social interactions study Jyang10@uclan.ac.uk

Social interactions study Labell@uclan.ac.uk

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Social interactions study Jyang10@uclan.ac.uk

Appendix 17 AU Lookout Advertisement of the Observation Study

Female participants wanted

Are you interested in how personality traits influence your perceptions of friendship?
Would you like to take part in research with a close friend?
Would you like to gain 6 SONA points? (if a psychology student)

If so, please come along to our research.

If you would like to participate, we will give your four questions about friendships to discuss with a close friend for 15 minutes.

We will film your chat because we are interested in your behaviour during the discussion. All your video footage will be saved in secure University computers and only accessed by the authorised individuals (e.g. researchers and research supervisors).

If you agree to take part, you will also be given some questionnaires asking about how you feel about the interaction and some personality traits that we are interested in. Each of you will fill the questionnaires independently. To complete all the questionnaires will take you 20 to 30 minutes.

Exclusion criteria: Participants must be female and you need to have English as your first language.

If you would like to take part or have any questions please contact the PhD Researchers LAbell@uclan.ac.uk or JYang10@uclan.ac.uk

Appendix 18 Follow Up Email Inviting Participants to Take Part in the Cognitive Study in 10 Month's Time

Hi,

Thank you for participating in my research project in October/November/December. I really appreciate the amount of time and effort you have provided to this project. I would like to invite you to come back to complete the study. As it is now 10 months since the first part of the study, I would like to do some follow up data tracking to see if there is anything in particular that has changed and might more accurately represent your general feeling about yourself and other people. Just to remind you that the study is about how a person's social relationships affect the way they pe rceive themselves and others and how they process social information.

If you would like to take part, the study will repeat the same procedure as last time. I will distribute 7 questionnaires (social anxiety, trait anxiety, depression, social desirability, loneliness, emotional intelligence and trust belief) and these will take you 30 minutes to complete. This can be done online (the online questionnaires: Link) or by hand (if you would like to do this, please contact me via email and I will invite you to the lab and you can fill the questionnaires on paper or you can take a questionnaire pack away. You can return the questionnaire to me in person, through my pigeon hole or drop it in my cardboard box in Darwin Psychology Office).

You will then be invited back to the lab to complete 3 different computer based tasks, each of which will take 10 to 15 minutes to complete. As before, the tasks will be set in Room 108 in Darwin building second floor. I will contact you via email to book the time available for both of us.

Thank you very much for your help.

I understand that you might have changed your mind and wish not to participate in this aspect of the study. If this is the case, you can withdraw your participation and your contact details and name will be deleted (your questionnaire results will be retained anonymously unless you want to withdraw). To do this, you can email me. You do not need to explain the reason(s) for withdrawal. Thanks again for your contribution.

If you have any questions about the study, please do not hesitate to contact me and my supervisor. Thanks.

Regards,

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Dr. Pamela Qualter
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