Psychophysiological Markers of Flow-Feeling in Artistic Appreciation

by

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Abstract

The purpose of this study was to examine the psychophysiological markers of aesthetic appraisals of graffiti art. Thirty-two participants had their Encephalogram (EEG) brain activity continuously monitored while gazing at art pieces of varying complexity and conceptual fluency levels: Low Complexity and Low Fluency (LCLF); Medium Complexity and Medium Fluency (MCMF); and High Complexity and High Fluency (HCHF). After gazing at each art piece, participants provided subjective measures of aesthetic appreciation, arousal, and pleasantness states. Experiment 1 involved 16 participants (eight males and eight females) aged between 18-45 years old (M = 23.69, SD = 4.74), with results revealing a linear increase in all subjective self-report ratings across LCLF, MCMF and HCHF categories. Significant differences in *alpha* activity across image categories also arose in channels T3, T5 and T6 for HCHF, in comparison to the MCMF and LCLF image categories. Experiment 2 involved 16 participants comprising 8 males and 8 females aged between 18-45 years old (M = 27.00, SD = 7.40), with results again revealing a significant linear increase across image categories in all subjective reports. The EEG data revealed significant differences in *alpha* power between initial and reflective viewing times for most EEG channels and a significant difference in *alpha* activity across image categories for channels T3, O1 and O2. Additionally, no correlation was found between the subjective self-reports of flow states and alpha power. Together, these findings suggest that different levels of complexity and conceptual fluency reveal different patterns of *alpha* activity in the brain related to inner monologues and visual attention networks.

Keywords: street art; flow-feeling; conceptual fluency; complexity; alpha peak

Introduction

Since the occurrence of art approximately 30,000 years ago, human beings have developed an interest in creating and appreciating works of art (Consoli, 2014; Humphrey, 1998). Recent research has examined the psychophysiological mechanisms underlying the perception of beauty and aesthetic emotions provoked by art, referred to as aesthetic appreciation (Peterson & Seligman, 2004). To this extent, Leder, Belke, Oeberst, and Augustin (2004) proposed five stages of aesthetic processing, which are perception, explicit classification, implicit classification, cognitive mastering and evaluation. This model distinguishes between aesthetic emotions and aesthetic judgments, proposing that these arise from two different processes, namely automatic and deliberate. However, Bullot, and Reber (2013) proposed that "emotional experience" and "artistic understanding" processes are combined through the Psycho-Historical Framework Model. Recently, research by Pelowski, Markey, Forster, Gerger, and Leder (2017) suggested that aesthetic emotional experiences emerge during the first step of aesthetic appreciation (i.e., a "pre-classification" stage) according to the Vienna Integrated Model of Art Perception (VIMAP). Although these models differ in their specific tenets, they nevertheless all propose that aesthetic appreciation is likely to prompt certain psychophysiological states.

Aesthetic Appraisal

Key theories of aesthetic appraisal are discussed in this section, including Value Theory, the Inverted-U Hypothesis, and Dual Processing Theory.

Value Theory

Value theory (Orsi, 2015), which was initially proposed by Plato (1974, D. Lee, Trans.) in the "Republic", has been studied by philosophers for many centuries and seeks to explain and understand how, why and to what degree an individual values a person, idea or an object. Plato proposed that there are two main categories of value, that is, instrumental value and intrinsic value. Instrumental value is defined as something that serves as a means to obtain something else that is valued (e.g., money). Intrinsic value is defined as something (e.g., moral integrity) that is valuable for its own sake independently of external (good or bad) outcomes (Wood, 2006). Value theory is important to consider when examining aesthetic appraisals of art because different people value different pieces of art based on their own unique emotional responses, which may be provoked by different art styles, such as representational and abstract art (Gu, Gao, Yan, Wang, & Tang, 2018; Zaidel, Nadal, Flexas, & Munar, 2013). In addition to value, *flow* states may be closely related to aesthetic experiences and liking, as discussed in the next section.

Flow Theory

Csikszentmihályi (1975; 2000) proposed the theory of flow, which is described as a positive affective mental state characterised by complete concentration and absorption in a specific task in the present moment. Specifically, Csikszentmihályi (1975; 2000) identified eight main characteristics of flow states: (1) challenge and skill balance, (2) clear goals, (3) automaticity and immediate feedback, (4) intense concentration, (5) time distortion, (6) paradox of control, (7) loss of self-consciousness and (8) self-rewarding autotelic experiences. Consequently, flow is a state of intense concentration accompanied by automaticity and immersion, resulting in suppression of any sense of self, time and bodily functions (Csikszentmihályi, 1975, 2000).

Furthermore, Csikszentmihályi and Robinson (1990) proposed that aesthetic experiences may be associated with fundamental dimensions of flow (e.g., level of challenge, skill and autotelic experiences). During this phenomenon, total concentration on a particular object or activity may occur, evoking a distorted sense of time and a loss of self-consciousness (Csikszentmihályi, 1975; 2000; Csikszentmihályi & Robinson, 1990). Recently, researchers have examined the relationship between flow and creativity in the artistic domain (Cseh, 2016). Aesthetic experiences share similarities with the concept of flow coined by Csikszentmihályi (1975; 2000). As previously stated, aesthetic experiences have previously been linked to flow-feeling states (Wazner, Finley, Zarian, & Cortez 2018). According to Csikszentmihályi, (1975, 2000), flow states require the narrowing of a person's attentional resources on a clearly defined goal, which then creates a state of deep concentration and a loss of sense of time. Furthermore, aesthetic appraisals are actively goal orientated and rely on an individual's distinct goals, values, and the affect it has on their interpretation of the artwork (Shimamura, & Palmer, 2013). In the present studies, participants were asked to view and rate the complexity and conceptual fluency of each individual artwork that was presented to them. As a result, three main characteristics of flow states (i.e., flow, concentration and time distortion; see Csikszentmihályi, 1975, 2000) were adapted in the form of self-reports. These three main characteristics were deemed to be the most relevant aspects of flow during the active viewing of artworks (cf. Marković, 2012). Therefore, it is acknowledged that the present research project did not target all aspects of flow-feeling, but only focused on those relevant to the aesthetic judgment task. In this regard, researchers have commented that theoretical frameworks can be tested in full or in part (e.g., Jackson, Eklund, & Martin, 2008; 2010).

In addition to flow states, the relationship between feelings of arousal and perceived processing fluency with respect to a given piece of art may affect aesthetic liking. This relationship may be explained through the *Inverted-U Hypothesis*, as elaborated upon in the next section.

The Inverted-U Hypothesis

The Inverted-U Hypothesis describes the relationship between perception, arousal and reward systems. Berlyne (1971) related this hypothesis to aesthetic appraisals. First, Berlyne noted that artworks vary in levels of processing fluency. Fluency refers to the relative ease of processing an image, which may affect aesthetic liking (Belke, Leder, Strobach, & Carbon, 2010). Second, he highlighted the *Inverted-U* relationship between arousal and hedonic tone (i.e., pleasantness, preference and utility), as low and high arousal levels are associated with low levels of hedonic tone (i.e., decreased aesthetic pleasure), whereas, moderate levels of arousal are linked to high hedonic tone (i.e., increased aesthetic pleasure). Third, Berlyne observed that aesthetic features (e.g., symmetry, novelty, uncertainty and conflict) are linked to high arousal and hedonic tone levels, revealing a curvilinear relationship between arousal and aesthetic liking.

Alternatively, Reber, Schwarz, and Winkielman (2004) proposed the *Hedonic Fluency Hypothesis*, which argued that high-fluency stimuli (e.g., artworks) may elicit positive affective states. Notably, a linear decreasing relationship between high complexity artworks and aesthetic liking was observed (see also Munsinger & Kessen, 1964; Winkielman, Schwarz, Fazendeiro, & Reber, 2003). Furthermore, Reber et al. (2004) argued that this relationship is not always found and sometimes an *Inverted-U* curvelinear relationship arises in which individuals reveal an increased preference for moderate complexity artworks and dislike low and high complexity artworks. Reber et al. (2004) explained these findings in terms of low levels of complexity making the source of fluency salient (i.e., participants are aware that high fluency arises from high simplicity) which suppresses the normal high fluency-liking attribution. As a result, as complexity increases the salience of the source of fluency decreases which in turn increases aesthetic liking for moderately complex items. Further increases in complexity lead to reduced processing fluency and reduced aesthetic liking.

In this regard, Marin, Lampatz, Wandi, and Leder (2016) examined the relationship between hedonic tone and complexity of environmental and representational scenes, and cartoon paintings. Marin et al.’s (2016) analysis revealed: (a) a strong relationship between complexity, arousal and beauty when controlling for image familiarity effects; (b) that complexity and pleasantness were inversely related (r_s= -.26); and (c) that complexity and liking were inversely related ($r_{s\,=}$ .29). Notably, additional studies examining affective environmental scenes and representational paintings have supported the *Inverted-U Hypothesis* (Berlyne, 1971; Marin & Leder, 2016; Munsinger & Kessen, 1964; Vitz, 1966), insofar that the more conceptually fluent (i.e., the ease of which perceivers can process a piece of artwork), the more positive the aesthetic response.

Importantly, there is also research questioning whether the *Inverted-U Hypothesis* can explain the relationship between complexity, conceptual fluency and aesthetic liking. Martindale, Moore, and Borkum (1990) did not support the findings of the *Inverted-U Hypothesis* and observed that aesthetic liking was related to conceptual fluency through a monotonic or U-shaped relationship. Additionally, individual differences on aesthetic preferences have been previously observed in other studies (Jacobsen & Höfel, 2002). It was confirmed that, on average, individuals preferred higher levels of complexity and symmetry in graphic patterns. However, the sample of participants also included individuals who preferred low complexity art pieces.

In addition, Silvia (2005) found that people who perceived certain images to be “more interesting” appraised them as more complex and comprehensible, suggesting that “complexity” and “conceptual fluency” are multifaceted phenomena, whose relationship might be influenced by other variables. Moreover, Nadal, Munar, Marty, and Cela-Conde (2010) examined inconsistencies in the bulk of research on this topic, concluding that the *Hedonic Fluency Hypothesis* does not account for all observed findings. In other words, the stimulus complexity of the image does not always show the *Inverted-U* pattern.

Moreover, Gerger and Leder (2015) examined abstract, semi-abstract and abstract paintings and whether semantically matching titles would increase perceived fluency and hedonic value. Gerger and Leder (2015) revealed that matching titles and no title conditions were more likely to produce increased aesthetic liking, positive emotions and fluency. Furthermore, moderate levels of cognitive effort were related to positive aesthetic experiences, suggesting that high levels of cognitive effort and disfluency may lead to decreased aesthetic liking. For this reason, alternative theories, such as the *Pleasure-Interest Model of Aesthetic Liking* (Graf & Landwehr, 2015) have been proposed as an alternative explanation of aesthetic experiences, as discussed in the next section.

Dual Processing Theory

Aesthetic appraisals may be affected by fluency in nuanced ways according to the *Pleasure-Interest Model of Aesthetic Liking* (PIA; see Graf & Landwehr, 2015). This framework purports that aesthetic appraisal is related to main two processes: (1) stimulus-driven processes, which involve automatic processing of subjective judgments of pleasure or displeasure; and (2) perceiver-based controlled processes, which involve three main outcomes of subjective judgments of interest, boredom and confusion. Particularly, an interaction between the stimulus and individual may influence aesthetic liking. In fact, research has supported the existence of two levels of processing during aesthetic appraisals, with Marković (2012) proposing that two parallel levels of processing (i.e., story/theme and symbolism/deeper meanings) interact during an aesthetic appraisal. Empirical evidence supporting the PIA model also stems from previous studies on the effects of semantic priming of aesthetic appraisals of car interior designs (Faerber, Leder, Gerger, & Carbon, 2010), and research on active processing during the aesthetic appraisal of typical and atypical car designs (Landwehr, Wentzel, & Herrmann, 2013). Muth and Carbon (2013) have also provide support for the PIA model, by showing that perceptual challenge refers to insight and creative problem-solving skills, in which an “aha!” moment of perceptual insight occurs during the conscious and deliberative evaluation of disfluent artwork.

Furthermore, Sherman, Grabowecky, and Suzuki (2015) have shown that aesthetic appraisals increased when the visual complexity of the artwork matched the individual's visual working memory capacity. That is, aesthetic appraisals are influenced by the complexity of the stimuli and by individuals' perceptual and processing ability. In other words, individuals with higher visual working memory capacity prefer artworks with greater visual complexity, whereas individuals with lower working memory capacity tend to prefer less complex artworks. Additionally, Graf and Landwehr (2017) examined abstract art of low, moderate and high fluency, and observed that stimulus fluency and interest are related through a reduction of disfluency. More simply explained, disfluent stimuli become more fluent through processing efforts and become more interesting, thus supporting the main tenets of the PIA model.

Alpha Waves During Aesthetic Experiences

Alpha brain waves (8-12 Hz) are associated with a relaxed and alert mental state (Kropotov, 2016). A peak on alpha activity, referred to as alpha peak, has been found during visual attention, executive and contextual functions (Palva & Palva, 2011), working memory (Manza, Hau, & Leung, 2014), object recognition and visual encoding (Klimesch, Fellinger, & Freunberger, 2011), and sensory perception (Foxe, & Snyder, 2011). To this extent, Bos (2006) has shown that alpha frequencies in the parietal and occipital regions are correlated to visual attention, sensory, motor and memory functions.

More recently, research has examined the role of alpha power on aesthetic appraisals. Cheung, Law, and Yip (2014) examined the neurophysiological markers of aesthetic judgments of beautiful and ugly appearance styles compared to baseline measurements. They concluded that during beautiful aesthetic judgments, increased positive alpha asymmetry was present in the frontal area and evokes a positive emotional state as the brain works towards integrating visual information with attentional processes. Recently, Cheung, Law, Yip, and

Wong (2019) have replicated and expanded these findings in a study exploring emotional responses to two different types of visual stimuli. Cheung et al. (2019) found that: (a) positive frontal alpha asymmetry was evoked when participants appraised visual art as either beautiful or not beautiful; and (b) positive frontal alpha asymmetry and negative frontal alpha asymmetry were evoked when participants appraised commercial art as beautiful and ugly, respectively. Thus, together these findings suggest that alpha brain waves are implicated in aesthetic appraisals of both beautiful and ugly artworks.

Researchers have also examined the role of alpha brain activity on aesthetic appraisals of different art styles, creativity, and problem solving. Jung-Beeman, Bowden, Haberman, Frymiare, and Armabel-Liu (2004) found differences in the alpha band during insight and non-insight problem solving tasks. Moreover, Jung-Beeman et al. (2004) found that alpha relative power in the parietal-occipital cortex is associated with idling and inhibition of visual inputs, which are related to aesthetic appraisals, as when people are gazing at an art image to understand its meaning. In fact, this pattern of neural activation has long been related to object recognition, which is a function of the ventral pathway related to the visual system (Ungerleider & Mishkin, 1982).

Regarding creativity, Luft, Zioga, Thompson, Banissy, and Bhattacharya (2018) examined the underlying neural mechanism involved in creative thinking. Four experiments revealed that EEG alpha activity in the right temporal lobe was related to inhibiting obvious semantic associations in the brain. Such an inhibition process is important to suppress distractions and block out irrelevant information during visual search and thus facilitate problem solving through both convergent and divergent thinking associations.

Moreover, EEG studies have focused on Event-Related Potentials (ERPs) to examine pleasant and unpleasant images. Bradley, Hamby, Löw, and Lang (2007) observed that: (a) pictures with emotional content elicited a larger positive potential across centro-parietal regions, with respect to neutral pictures; and (b) picture composition evoked less positivity over posterior areas and less negativity over frontal regions. Together these findings suggest that different neural patterns are linked to the appraisal of picture composition of emotional and neutral images.

The processes underlying aesthetic judgments have also been examined using ERP paradigms. Höfel and Jacobsen (2007) compared participants in a so-called “viewing condition” (i.e., participants were instructed to gaze at graphic patterns) to participants in a “contemplation condition” (i.e., participants were instructed to reflect on the beauty of the graphic patterns), concluding that the neural mechanisms of aesthetic judgments of beauty change if participants are instructed to contemplate rather than merely gaze at a given image, with early frontocentral negativity being observed among participants exposed to the viewing condition. That is, aesthetics judgments are influenced by intention and do not always arise spontaneously.

The present study examines alpha power within the 8-12 Hz alpha frequency band, thus allowing for recording power over specific regions of the scalp through each electrode. Notably, recording absolute alpha power allows for measurement of the amplitude/strength of this frequency, analyses of cortical activity across the scalp and examinination of specific points in time through Fast Fourier Transfer (FFT) analysis methods (Koenig & Pascual-Marqui, 2009). Relevant for this study, previous research has examined the relationship between reduced alpha power (i.e., cortical activity) and increased visual attention and interest, concluding that increased visual attention and interest is related to decreased alpha power (Gevins, Zeitlin, Doyle, Schaffer, & Callaway, 1980; Mulholland, 1973; Mulholland & Runnals, 1962). Furthermore, Shourie, Firoozabadi, and Badie (2014) examined EEG alpha power activity in artists and non-artists during the visual perception (i.e., mental imagery tasks and visual perception tasks) of paintings compared to baseline. Alpha power indicated a decrease in both groups suggesting that alpha power decreases occur during encoding of a memory task. Recently, Konston, Megjhani, Brantley, Cruz-Garza, and Nakagome (2015) studied the neural basis of aesthetic experiences using dry EEG on over 400 participants. Each piece of art was grouped into three categories (i.e., complex, moderate and baseline). Functional connectivity analysis revealed strong links between occipital (O1, OZ, O2 and PZ), particularly in the visual cortex, and the visual processing frontal areas (FC5, F3, and F4), which are related to emotional expression and aesthetic judgments.

Overall, a large body of research suggests that alpha brain rhythms are linked to aesthetic appraisals. The present study focuses on exploring whether aesthetic experiences may induce differences in psychophysiological states. Of note, aesthetic liking has been previously related to aesthetic experiences, as individuals ascribe subjective value and engage different cognitive resources to process art pieces of different beauty and complexity levels, as elaborated upon next.

Overall, the proposition that aesthetic appraisals are influenced by complexity is supported by existing previous research. Specifically, artworks that are more complex are more likely to be processed in a sequential order, whereas, less complex pieces of art are appraised quickly, without planning. Simply put, aesthetic appraisals are processed through two intertwined systems linked to fast (type 1) parallel processing, and deliberative (type 2) analytical thinking (Allen, & Thomas, 2011). Notably, different processing systems related to aesthetic appraisals reveal different neuropsychological mechanisms (Liu, Lughofer, & Zeng, 2017; Chatterjee, & Vartanian, 2016). Subjective value is also given to different styles of art and has been argued to be able to elicit different psychophysiological responses.

The Present Study

The present study is grounded on the PIA Model (see Graf & Landwehr, 2015) of aesthetic experiences in which perceived *fluency* and *complexity* influence the sensorial processing of an artwork, thus influencing aesthetic liking. In turn, aesthethic liking is thought to influence psychophysiological responses (Ball, Threadgold, Marsh, & Christensen, 2018; Belke, Leder, Strobach, & Carbon, 2010). This research hopes to extend the PIA Model through exploration of how artworks of different levels of fluency and complexity might influence different psychophysiological responses.

In summary, the overarching purpose of this research project was to explore the psychophysiological markers of aesthetic experiences of artworks of different fluency and complexity levels, as measured in terms of alpha peak, subjective reports of aesthetic liking, complexity, conceptual fluency, perceived flow-feeling experiences, concentration, time distortion, and aesthetic liking.

Experiment 1

Aims and Hypotheses

The purpose of Experiment 1 was to examine whether artworks of moderate complexity and conceptual fluency were more likely to induce psychophysiological markers of aesthetic experiences. The hypotheses were that: (H1) artworks appraised as “moderately complex and conceptually fluent” would elicit increased alpha activity across the brain (Ball et al., 2018; Commare, Rosenberg, & Leder, 2018; Graf, & Landwehr, 2017; Marin & Leder, 2016). Furthermore, as flow is a positively valenced state (Tian, Bian, Han, Wang, Gao, & Chen, 2017) participants were expected to report higher levels of flow and more positive affective states for the artworks of moderate complexity and conceptual fluency, in comparison to the artworks of low or high complexity and conceptual fluency (H2).

Methods

Pilot Experiment

A pilot experiment was conducted to categorise a large number of images of street art into low, moderate and high complexity and conceptual fluency levels. The pilot study was conducted as two separate online questionnaires using the Qualtrics platform (see Appendix A for an example of the questionnaires). One questionnaire measured the ratings of complexity and another measured ratings of conceptual fluency. A total of 211 participants were recruited through an opportunity sample online using Prolific Academic. Ninety-nine participants completed the conceptual fluency questionnaire. The full questionnaire is available online (https://uclan.eu.qualtrics.com/jfe/form/SV_d1n6DTZLYw0opUh). Some participants chose not to record their demographic information and therefore the demographic statistics were based on the participants who completed this part of the questionnaires. The sample, comprised of 48 males, 50 females, and one undisclosed gender, was between 18-45 years old (M = 28.05, SD = 7.43). Additionally, 101 participants completed the complexity questionnaire. The full questionnaire is available online (https://uclan.eu.qualtrics.com/jfe/form/SV_aaPkdNtvL9djWex). The sample comprised of 53 males and 48 females between 18-45 years of age (M = 27.29, SD = 7.90). The participant pool was recruited from various parts of the world including Brazil, Canada, Germany, Greece, Italy, Jamaica, Mexico, Poland, Portugal, United Kingdom, and United States (see Appendix B for demographic information). All participants were fluent in English and confirmed prior to taking part that they had corrected-to-normal vision and no visual impairments. Children under the age of 16, vulnerable adults with learning disabilities, and adults with mild cognitive impairments were excluded from participating in this study. A specific briefing form (see Appendix C), informed consent form (Appendix D) and debrief form (Appendix E) were provided for this group of participants, who were also asked to respond to demographic questions (Appendix F).

As noted above, two separate questionnaires for complexity and conceptual fluency were distributed to two different groups of participants. This was to avoid: (a) an overlap of participants who had already provided a rating on one of the questionnaires; and (b) the possibility that participants would become confused between the ratings of complexity and conceptual fluency, consistent with previous work (Ball et al., 2018). Participants were asked to provide ratings for 195 photos of street art in terms of complexity and conceptual fluency. All images are stored online on the UCLAN data repository and can be downloaded using this link (https://doi.org/10.17030/uclan.data.00000243). More precisely, participants were asked to appraise each image within 30 seconds in accordance to complexity using a scale ranging from 0 (not at all complex) to 100 (very complex) and conceptual fluency from 0 (not at all meaningful) to 100 (very meaningful).

The questionnaire data were inputted into IBM Statistical Package for Social Sciences (SPSS) version 25. Exploratory curve-fit estimations were computed and revealed that the relationship between complexity and conceptual fluency was linear (Appendix G). As complexity and conceptual fluency increased linearly, these two categories were grouped together. The first step of image categorisation was to standardise (Z-score values) the participants' ratings for complexity and conceptual fluency. Standardised values of -.1 were categorised as "Low Complexity, Low Conceptual Fluency" (LCLF), values between -.20 and +.20 were categorised as "Moderate Complexity, Moderate Conceptual Fluency" (MCMF) and values of +.1 were categorised as "High Complexity, High Fluency (HCHF). These values reflect current guidelines on small, moderate, and large effect sizes (see Prajapati, Dunne, & Armstrong, 2010; Clayson, Carbine, Baldwin, & Larson, 2019). Images outside these ranges were not considered further. After the categorisation stage, 27 final images were clustered into three main blocks (Appendix H), namely LCLF (n = 9), MCMF (n = 9) and HCHF (n = 9). The overall average viewing time for each image across conditions was 7.96 sec (SD = 0.53). Precisely, on average, the participants spent 7.69 sec (SD = 0.57) gazing at LCLF images, 8.08 sec (SD = 0.58) gazing at MCMF images, and 8.12 sec (SD = 0.36) gazing at HCHF images.

Participants

The approximate sample size for Experiment 1 was calculated through an a priori power analysis (d = .60, 1-β = .80, α= .05), which was informed by previous research on the neural markers of peak performance experiences (Bertollo, di Fronso, Filho, Conforto Schmid, Bortoli, Comani, & Robazza, 2016). In total, 16 participants were recruited via an opportunity sample of the general population, which comprised eight males and eight females aged between 18-45 years old, (M = 23.69, SD = 4.74). All participants had corrected-to-normal vision and no visual impairments. They all spoke fluent English and understood verbal instructions. Children under the age of 16, vulnerable adults and participants with known neurological disorders were excluded from participating in this study. An Amazon voucher of £10 was provided to compensate participants for their time. Ethical approval for this study was granted through the Psychology and Social Science Ethics Review Panel at the University of Central Lancashire (Appendix I).

Subjective Reports

Participants were asked to provide self-reports of aesthetic liking, complexity, conceptual fluency, perceived flow-feeling experiences, concentration, time distortion, and aesthetic liking (Appendix J).

Aesthetic Liking

Congruent with previous research (Graf, Mayer, & Landwehr, 2017), participants were asked to provide their ratings of aesthetic liking through a single-item measure. Participants were asked to answer the question “How much did you like the image?” on a Likert scale ranging from 0 (not at all) to 10 (very much).

Conceptual Fluency

Conceptual fluency was assessed using a single-item measure similar to previous research on art aesthetics (see Ball et al., 2018). Participants were asked to answer the question “How meaningful was the image to you?” on a Likert scale ranging from 0 (not meaningful at all) to 100 (very meaningful).

Complexity

Complexity was measured using a single-item measure in accordance to previous research (see Ball et al., 2018). Participants were asked to answer the question “How complex was the image to you?” on a Likert scale ranging from 0 (not meaningful at all) to 100 (very meaningful).

Flow-Feeling Scales

Three single-item measures, based on the Short Flow State Scale and the Core Dispositional Flow Scale (Jackson, Eklund, & Martin, 2008, 2010), were designed to measure overall perceptions of *flow, concentration* and *time distortion* following the presentation of each painting. Single item measures are recommended in psychophysiological research, because they can be administered in a fast and efficient manner (Boateng, Neilands, Frongillo, Melgar-Quiñonez, & Young, 2018). The Short Flow State Scale and Core Dispositional Flow Scales have been designed to measure the nine dimensions of flow, in line with Csikszentmihályi's theory of flow (1975, 2000).

These three dimensions of flow states were measured because they were the most relevant to the task, which involved active observation of artworks. Regarding overall perception of flow (Item 4) from the Core Dispositional Flow Scale, the participants were asked to respond to the question: "Did you feel like you were 'in the zone' while you were gazing at the image?" on a Likert scale ranging from 0 (not at all) to 10 (very much). Regarding concentration (Item 5) from the Short Flow State Scale, the participants were asked to respond to the question: "How focused did you feel while looking at the image?" on a Likert scale ranging from 0 (not at all to) to 10 (very much). Regarding time distortion (Item 8) from the Short Flow State Scale, the participants were asked to respond to the question: "Did you feel time passing at a different pace while you were looking at the image?" on a Likert scale ranging from 0 (not at all) to 10 (very much).

Arousal and Pleasantness States

An adapted version of the Affect Grid was used to assess affect through the use of single-item measures of *arousal* and *pleasantness* (Russell, Weiss, & Mendelsohn, 1989). Explicitly, participants were asked to respond to the question "How activated did you feel while looking at the image?" on a Likert scale ranging from 0 (total sleepiness) to 10 (highly activated) Additionally, participants were asked "How pleasant/enjoyable was it to look at the image?" on a Likert scale ranging from 0 (not at all pleasant) to 10 (highly pleasant).

EEG Recordings

The NeXus-32 biofeedback system was used to record EEG alpha brain waves throughout the full duration of the experimental task (Mind Media, 2017). Specifically, Alpha Absolute Power was measured in microvolts squared (μV^2) throughout the experiment at a sampling frequency of 256 Hz. The data were acquired using the common average reference approach, which averaged the amount of power throughout all of the EEG electrodes. The data were acquired from an EEG cap manufactured by Mind Media, which had a total of 21 EEG electrodes (Figure 1), which were referenced to A1 and A2 electrodes. The ground electrode was located at channel Afz, between channels Fpz and Fz. The electrodes were positioned over the scalp and followed the 10/20 system (Acharya, Hani, Cheek, Thirumala, & Tsuchida, 2016). Impedance values below ($Z < 10$ kΩ) were maintained during data collection.

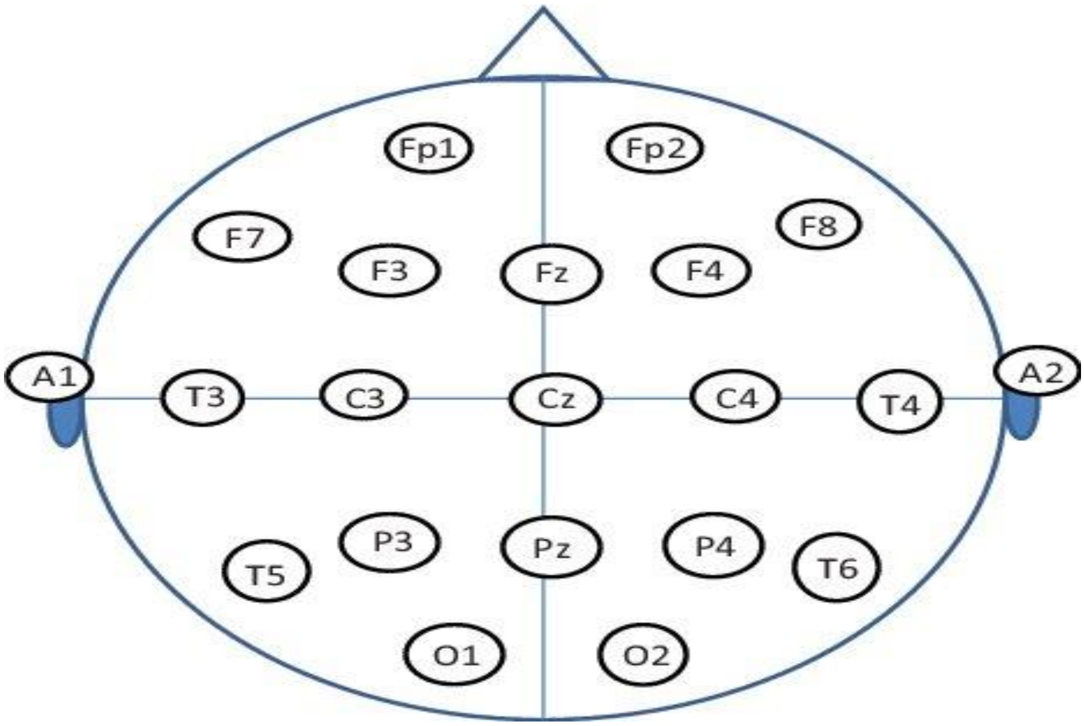

Figure 1. Diagram of the 21 EEG electrode cap.

Alpha Power

Increased alpha waves (8-12 Hz) are linked to attentional processing, memory, inhibition and reduced stress and anxiety (Klimesch, 2012). Additionally, alpha waves have been linked to a state of wakeful relaxation (Roohi-Azizi, Azimi, Heysieattalab, & Aamidfar, 2017). Particularly within the field of neuroaesthetics, alpha power has been linked to increased relaxation and engagement of attention during aesthetic judgements, which enhance the processing of visual attributes (Cheung et al., 2014).

Experimental Task

This study consisted of a repeated measures design. As previously stated during the pilot study, the images were categorised into three main groups (i.e., LCLF, MCMF and HCHF), which represent the independent variables in this study. All participants appraised all three categories of images. The experimental task involved viewing images of street art and providing subjective ratings for each image (Figure 1). Congruent with previous research on visual stimuli and EEG recordings (Yuvaraj, Murugappan, Ibrahim, Omar, & Sundaraj, 2014), the image categories (LCLF, MCMF, HCHF) were presented in three blocks, each containing nine images, and the participants were allowed a 5-minute break in between the blocks. The order of each block was counterbalanced and the presentation order of each image within a given block was randomised (see Appendix K for an example of the counterbalancing and randomisation procedure for Experiment 1 and Experiment 2). Each image was presented and involved an imposed viewing time of eight seconds in total per image, as per the findings of the pilot study. This time window coincides with previous research suggesting that that 6-15 second windows should be considered in the analysis of bio-signal data (Kim, Bang, & Kim, 2004; Yuvaraj et al., 2014).

Figure 2. Experimental set up.

It should be noted that before and after the presentation of each image, a white blank screen (i.e., inter-trial interval) was displayed for three seconds (Figure 2). This idea of a “neutral” stimulus is congruent with previous research in video and image-based stimuli tasks (Van Rooijen, Ploeger, & Kret, 2017; Yuvaraj et al., 2014). Following the presentation of each image, participants were asked to report their subjective ratings of flow, concentration, time distortion, activation, pleasantness, aesthetic liking, conceptual fluency and complexity.

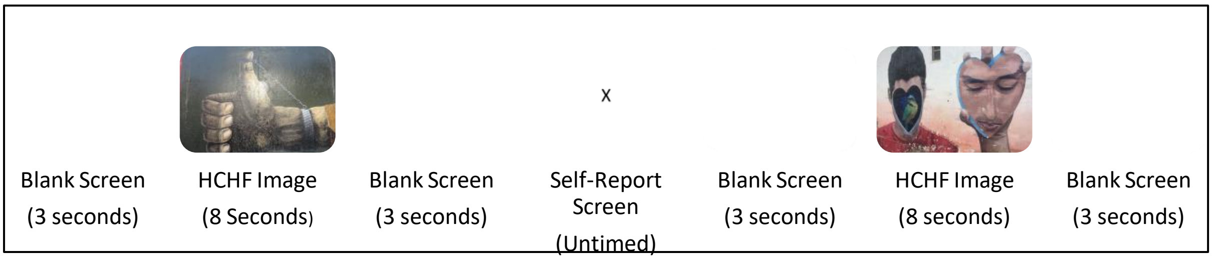

Figure 3. Schematic representation of the experimental task for Experiment 1.

Procedures

Participants were provided with a briefing (Appendix L), which explained voluntary participation, data anonymity, withdrawal procedures, omissions, and debriefing. The participants signed an informed consent form before taking part in the study (Appendix M). Demographic information was gathered from each participant (Appendix N). Next, the EEG cap and gel application commenced. The impedance of the nodes was below 10,000 kΩ and the sampling frequency was set at 256 Hz. A checklist for the experimental protocol was referred to throughout (Appendix O), thus ensuring the delivery of standardised instructions to each participant (Appendix P). A pushbutton trigger marked the beginning and end of each baseline and image. A four-minute baseline was recorded whilst participants' eyes were closed (two minutes) and then open (two minutes). Each image was presented on a PowerPoint presentation slide and was time locked in accordance with the EEG recording markers. Before the presentation of each image, a three-second blank screen was presented. Following this, a marker was pressed as the image was presented for eight seconds and then pressed after the image disappeared, followed by a three second blank screen. The PowerPoint presentation changed to an untimed slide marked with a centred "X" to provide time for the self-report measures after the presentation of each image.

The participants' self-reports on the measures detailed above were recorded by the researcher (Appendix Q). This procedure was repeated until all images were presented. A total of 27 images were presented. Each image category (LCLF, MCMF and HCHF) was separated into three blocks, which contained nine images per block. At the end of blocks one and two, a five-minute break was provided. At the end of the experiment, which lasted approximately two hours, the participants were debriefed about the research hypotheses, theoretical background, and were provided with an opportunity to ask questions (Appendix R).

Data Analysis

All of the subjective report data across LCLF, MCMF and HCHF categories were inputted and analysed using SPSS 25. The BioTrace+ software was used to collect, filter and export the EEG data. First, the data were segmented to select the data between the markers of the beginning and end of the eight second time window in which each image was presented. Second, the EEG data were Fast Fourier Transformed (FFT) on BioTrace+. Third, the EEG data were exported to Excel to be sorted by image and then transferred to IBM SPSS 25 for statistical analysis. Univariate outlier analysis was carried out in line with current multivariate statistic guidelines (Hair, Black, Babin, & Anderson, 2014, p. 66). To be explicit, absolute Z-scores values above 2.5 were removed from the data set.

Experiment 1 Results

Results for the subjective data analysis are presented first. Subsequently, the findings for the objective data are presented.

Subjective Measures

Means, standard deviations and *p*-values for the aesthetic subjective self-report measures, aesthetic liking, complexity and inferential statistics for all subjective variables are presented in Tables 1 and 2 akin to current American Psychological Association (APA) guidelines (see Appelbaum, Kline, Nezu, Cooper, Mayo-Wilson, & Rao, 2018). A repeated measures Analysis of Variance (ANOVA) was conducted across LCLF, MCMF and HCHF categories of images (see http://uclandata.uclan.ac.uk/id/eprint/206 for the full output file). Post-hoc comparisons using the Bonferonni adjustment were conducted on the statistically significant results. Tests of within subjects contrasts was referred to so that the proper effect (i.e., linear or quadratic) for the self-reports could be identified.

Aesthetic Liking

The results revealed a significant difference in self-reported *aesthetic liking* between LCLF, MCMF and HCHF, $F(2, 286) = 40.50$, $p < .001$, $\eta 2 = .22$. Aesthetic liking ratings were the highest for HCHF image categories. This confirms the experimental manipulation, as more complex and conceptually fluent images received higher aesthetic liking ratings.

Conceptual Fluency

A significant difference in *conceptual fluency* self-report ratings between LCLF, MCMF and HCHF were revealed, $F(2,286) = 50.09$, $p < .001$, $\eta 2 = .26$ in the hypothesised direction (i.e., the higher the *conceptual fluency* in the pre-categorised images, the higher the subjective rating) confirming that the manipulation worked.

Complexity

The results indicated a significant difference in self-reports of *complexity* ratings between LCLF, MCMF and HCHF, $F(2,286) = 54.21$, $p < .001$, $\eta 2 = .28$ in the hypothesised direction, which predicted that HCHF image categories would reveal higher subjective ratings of complexity. These results also confirm that the manipulation check was successful.

Table 1

Means and Standard Deviations for Subjective Data Across LCLF, MCMF and HCHF

Variables	LCLF M (*SD*)	MCMF M (*SD*)	HCHF M (*SD*)	F (2, 286)	*p*	η_p^2	Post-Hoc
Subjective Data							
Aesthetic Liking***	4.03 (2.73)	5.60 (2.60)	6.71 (2.42)	40.50	<.001	.22	LCLF<MCMF<HCHF
Conceptual Fluency***	25.63 (22.24)	38.40 (24.80)	52.01 (29.46)	50.09	<.001	.26	LCLF<MCMF<HCHF
Complexity***	30.76 (22.50)	47.43 (24.46)	60.69 (25.77)	54.21	<.001	.28	LCLF<MCMF<HCHF

Note. LCLF = low complexity, low fluency; MCMF = moderate complexity, moderate fluency; HCHF = high complexity, high fluency; ** $p < .005$; *** $p < .001$

Flow

The results revealed a significant difference in self-reported experiences of *flow* throughout the LCLF, MCMF and HCHF conditions, $F(1.86, 266.54) = 36.80$, $p < .001$, $\eta_p^2 = .21$. These results suggest that there was a linear increase in self-reported flow-states from the LCLF to the HCHF category.

Concentration

Significant differences of self-reported concentration were revealed across LCLF, MCMF and HCHF, $F(1.91, 272.57) = 11.33$, $p < .001$, $\eta_p^2 = .07$. These results show that there was a linear increase in self-reported concentration throughout the LCLF, MCMF and HCHF categories.

Time distortion

A significant effect of time distortion was revealed, $F(1.86, 266.22) = 9.30$, $p < .001$, $\eta_p^2 = .06$. These results suggest that there was a significant increase of time distortion self-reports throughout the LCLF, MCMF and HCHF conditions.

Activation

The results indicate a significant difference in self-reported levels of *activation* throughout the LCLF, MCMF and HCHF categories of the images, $F(2, 286) = 15.81$, $p < .001$, $\eta_p^2 = .10$. These results suggest that there was a linear increase of activation levels.

Pleasantness

A significant effect of pleasantness was revealed, $F(1.93, 276.23) = 25.92$, $p < .001$, $\eta_p^2 = .15$. These results suggest that there was a significant increase of pleasantness self-reports throughout the LCLF, MCMF and HCHF categories.

Table 2

Means and Standard Deviations for Subjective Data Across LCLF, MCMF and HCHF

Variables	LCLF M (*SD*)	MCMF M (*SD*)	HCHF M (*SD*)	F (1.86, 266.54)	*p*	η_p^2	Post-Hoc
Subjective Data							
Flow***	4.66 (2.75)	5.94 (2.16)	6.56 (1.87)	36.80	<.001	.21	LCLF<MCMF<HCHF
Concentration***	6.25 (2.63)	6.56 (2.18)	7.22 (2.01)	11.33	<.001	.07	LCLF<MCMF<HCHF
Time Distortion***	4.24 (2.63)	4.68 (2.81)	5.42 (2.59)	9.30	<.001	.06	LCLF<MCMF<HCHF
Activation***	5.51 (2.35)	5.86 (2.16)	6.52 (1.97)	15.81	<.001	.10	LCLF<MCMF<HCHF
Pleasantness***	4.88 (2.44)	5.69 (2.18)	6.63 (2.08)	25.92	<.001	.15	LCLF<MCMF<HCHF

Note. LCLF = low complexity, low fluency; MCMF = moderate complexity, moderate fluency; HCHF = high complexity, high fluency; ** $p < .005$; *** $p < .001$.

Objective Measures

Means, standard deviations and *p*-values for all objective variables are presented in Table 3 and Figure 3 akin to current APA guidelines (see Appelbaum et al., 2018). Repeated measures ANOVA was conducted across LCLF, MCMF and HCHF categories of images (see http://uclandata.uclan.ac.uk/id/eprint/206 for the full output file). Post-hoc comparisons using the Bonferonni adjustment were conducted on the statistically significant results. Tests of within subjects contrasts were referred to so that the proper effect (i.e., linear or quadratic) for alpha power activity could be identified.

Alpha Power

Table 3 presents the means, standard deviations, F-values, estimates of effect size (η_p^2) and *p*-values for *alpha power* in all 19 EEG channels (see Figures 4 and 5 for a visual representation of the EEG data). Overall, the data revealed a mixture of patterns. F8 revealed an equal pattern between LCLF, MCMF and HCHF conditions. Similarly, Pz, P3 and C4 revealed low alpha activity in the LCLF condition, followed by equal activity in MCMF and HCHF conditions. Five EEG channels: F4, Cz, T6, P4 and O2 exhibited a linear pattern, meaning that alpha activity in the LCLF condition the was lowest, followed by MCMF and HCHF condition exhibiting the highest activity. On the other hand, channels F3 and T5 revealed a reverse linear pattern, in which the lowest activity was present in the HCHF condition, followed by MCMF and LCLF showing the highest activity. Four channels: F7, T3, T4 and O1 revealed a U-shaped pattern, in which alpha activity was the lowest in the MCMF condition, followed by the LCLF condition, with the highest activity in the HCHF condition. However, three channels, Fp1, Fp2 and Fz revealed a similar pattern but in the opposite direction, activity in the MCMF was lowest, followed by HCHF and then the highest activity was in LCLF. Statistical significance at alpha level ($p < .005$) was found in channels T5 and T6. Additionally, T3 was found to be statistically significant at alpha level ($p < .001$).

For a more detailed visual representation of alpha power in all 19 EEG channels (see Figure 5 which displays heat maps of absolute alpha power means). The heat maps display lowest alpha power activity in blue, the highest alpha power in red and average in green.

Table 3

Alpha Power Across LCLF, MCMF and HCHF Categories of Images

Brain Lobe	Variables	LCLF M (SD)	MCMF M (SD)	HCHF M (SD)	F (1.88, 136.92)	*p*	η_p^2	Post-Hoc
Frontal	Fp1	8.52 (3.14)	7.76 (3.19)	8.35 (2.97)	1.55	.216	.02	
	Fp2	8.52 (3.30)	7.97 (3.19)	8.17 (2.73)	1.02	.364	.01	
	F7	6.50 (2.70)	6.09 (2.17)	6.87 (3.26)	2.71	.069	.03	
	F3	5.97 (2.13)	5.83 (2.50)	5.68 (1.73)	0.60	.535	.01	
	Fz	9.40 (4.84)	9.29 (4.74)	9.31 (3.90)	0.03	.969	.00	
	F4	5.91 (2.15)	6.56 (4.04)	7.04 (3.82)	2.39	.105	.11	
	F8	7.77 (3.28)	7.75 (3.51)	7.73 (3.58)	0.01	.990	.00	
Central	C3	5.24 (2.46)	6.12 (3.97)	5.47 (2.83)	2.14	.126	.13	
	Cz	5.31 (1.77)	5.73 (2.98)	5.85 (2.61)	1.36	.259	.02	
	C4	4.90 (1.85)	5.75 (4.51)	5.78 (3.52)	2.59	.083	.03	
Temporal	T3***	4.13 (2.03)	3.47 (1.51)	5.27 (3.88)	12.28	<.001	.14	LCLF>MCMF<HCHF
	T4	3.43 (1.24)	3.31 (1.31)	3.96 (2.78)	2.94	.080	.04	
	T5**	5.75 (3.41)	5.15 (3.35)	4.29 (2.25)	6.75	.002	.09	LCLF>MCMF>HCHF
	T6**	3.92 (2.23)	4.76 (3.56)	5.26 (3.91)	6.44	.003	.07	LCLF<MCMF<HCHF
Parietal	P3	5.94 (3.07)	6.17 (4.36)	6.18 (4.14)	0.18	.821	.00	
	Pz	6.23 (2.97)	6.82 (4.38)	6.85 (3.50)	1.17	.308	.02	

Brain Lobe	Variables	LCLF M (SD)	MCMF M (SD)	HCHF M (SD)	F (1.88, 136.92)	*p*	η_p^2	Post-Hoc
	P4	4.27 (1.38)	4.83 (3.62)	5.29 (3.72)	2.50	.092	.04	
Occipital	O1	5.24 (2.88)	4.76 (2.09)	5.36 (2.89)	2.08	.129	.03	
	O2	4.61 (2.28)	4.79 (2.53)	5.03 (2.62)	1.43	.241	.02	

Note. LCLF = low complexity, low fluency; MCMF = moderate complexity, moderate fluency; HCHF = high complexity, high fluency; ** $p < .005$; *** $p < .001$; μV^2 = microvolts squared.

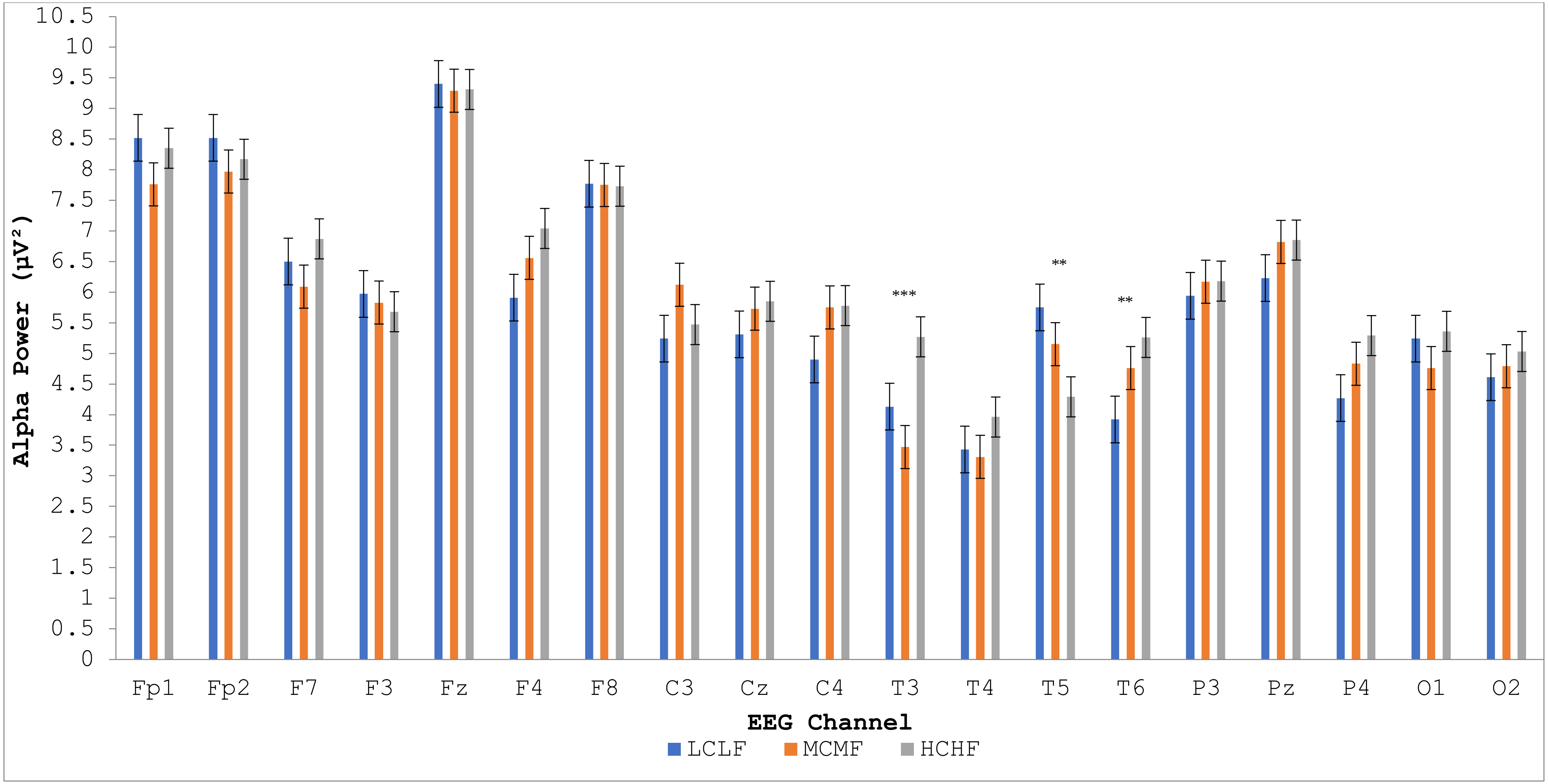

Figure 4. Alpha power (μV²) across all 19 EEG channels during the viewing of LCLF, MCMF and HCHF image categories.

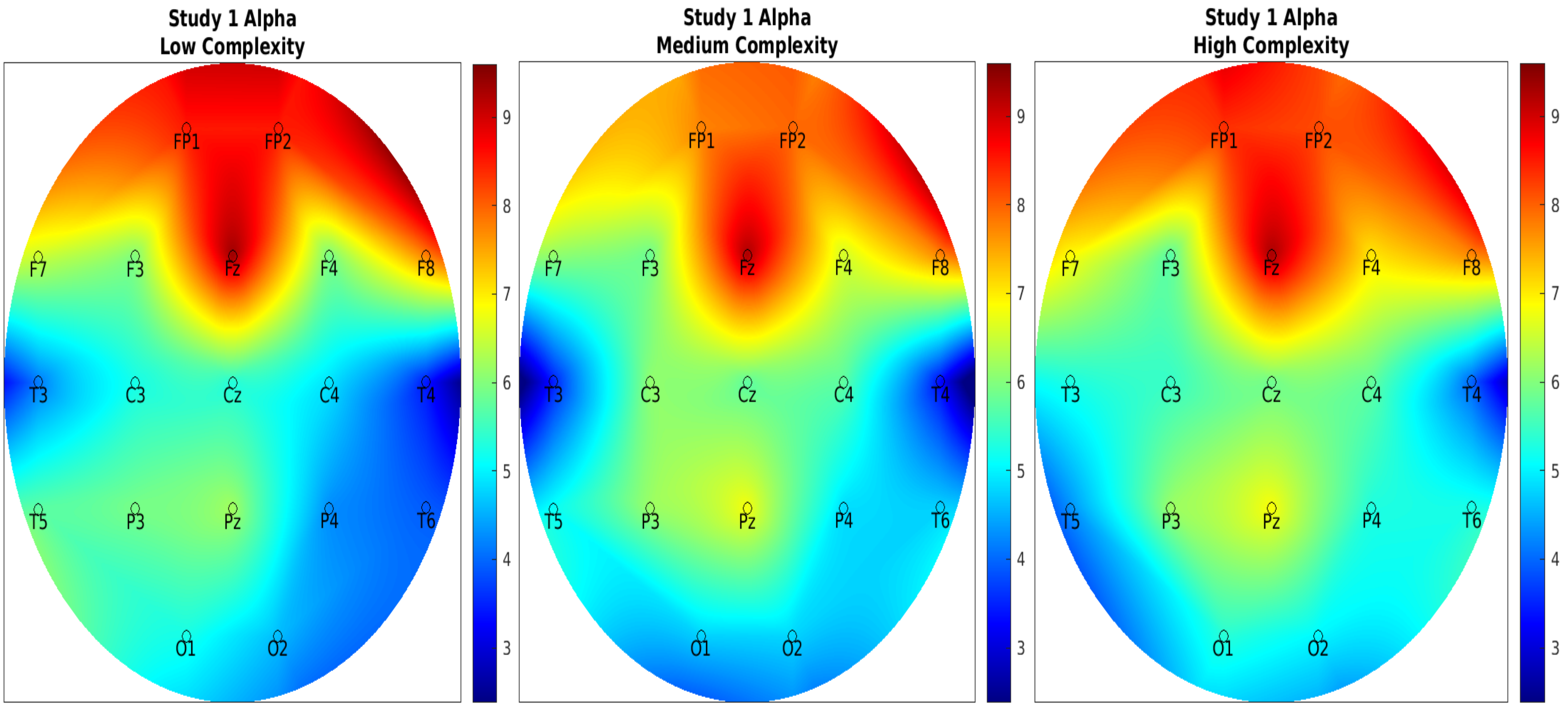

Figure 5. Heat maps of alpha power (μV²) (ranging from 3.31 (lowest in blue) to 9.40 (highest in red) across all 19 EEG channels during the viewing of LCLF (left), MCMF (middle), and HCHF (right) image categories.

Correlations

Pearson correlations were carried out between statistically significant subjective self-reports and EEG electrodes to examine the relationship between the subjective and objective variables (see Tables 4, 5 and 6). Across all three image categories, the relationship between self-reported flow, concentration, time distortion, activation and pleasantness were significant and positively correlated ($.27 < r > .71$). There was a positive correlation between all EEG channels across all three image categories.

In the LCLF image category, the relationship between flow and concentration ($r = .53$, $p < .001$) and flow and pleasantness ($r = .52$, $p < .001$) were moderate and positive linear relationships. The correlation between flow and time distortion was a weak positive linear relationship ($r = .30$, $p < .001$). This indicated that as the subjective reports of flow increased, the self-reports of concentration, time distortion and pleasantness also increased. Furthermore, the relationship between flow and alpha power in electrodes T3 ($r = .23$, $p < .005$), T5 ($r = .21$, $p < .005$) and T6 ($r = .22$, $p < .005$) were all indicative of a weak positive linear relationship. These findings suggest that as subjective self-reports of flow increased, alpha power in electrodes T3, T5 and T6 increased during the viewing of LCLF images.

In the MCMF image category, the relationship between flow and concentration ($r = .64$, $p < .001$), flow and activation ($r = .61$, $p < .001$), flow and time distortion ($r = .49$, $p < .001$), flow and pleasantness ($r = .58$, $p < .001$) were all a moderate positive linear relationship. These findings suggest that as subjective self-reports of flow increased, the subjective reports of concentration, activation, time distortion and pleasantness also increased. There were no significant findings of a correlation between flow and alpha power the EEG electrodes T3, T5 and T6 in the MCMF category of images.

In the HCHF image category, the relationship between flow and concentration ($r = .71$, $p < .001$) was a strong linear relationship. Correlations between flow and activation ($r =$

.53, p <.001) and, flow and pleasantness (r = .45, p <.001) revealed a moderate positive linear relationship. The relationship between flow and time distortion (r = .27, p <.001) indicated a weak positive linear relationship. These findings suggest that as subjective self-reports of flow increased, the self-reports of concentration, activation, pleasantness and time distortion increased as well. There were no significant findings of a correlation between flow and alpha power the EEG electrodes T3, T5 and T6 in the HCHF category of images.

Table 4

LCLF Subjective Self-Reports and Significant EEG Alpha Power Correlations

Variables	1	2	3	4	5	6	7	8	9
1. Flow***	1	.53***	.30***	.52***	.63***	.23**	-.10	.21**	.22**
2. Concentration***		1	.15	.76***	.60***	.09	-.23	.07	.09
3. Time Distortion***			1	.17**	.13	.06	-.10	.06	.11
4. Activation***				1	.51***	.22**	-.07	.11	.19
5. Pleasantness**					1	.24**	-.02	.04	.19
6. LCLF_T3***						1	-.04	.67***	.61***
7. LCLF_T4							1	.06	-.13
8. LCLF_T5***								1	.56***
9. LCLF_T6***									1

Note. LCLF = low complexity, low fluency; MCMF = moderate complexity, moderate fluency; HCHF = high complexity, high fluency; ** $p < .005$; *** $p < .001$.

Table 5

MCMF Subjective Self-Reports and Significant EEG Alpha Power Correlations

Variables	1	2	3	4	5	6	7	8	9
1. Flow***	1	.64***	.49***	.61***	.58***	-.02	-.00	.01	.07
2. Concentration***		1	.32***	.73***	.57***	.02	-.05	.02	.01
3. Time Distortion***			1	.34***	.42***	.07	-.07	-.09	-.03
4. Activation***				1	.52***	-.01	.02	.02	.11
5. Pleasantness					1	.09	-.11	-.09	.03
6. MCMF_T3***						1	.44***	.61***	.33***
7. MCMF_T4***							1	.71***	.79***
8. MCMF_T5***								1	.72***
9. MCMF_T6***									1

Note. LCLF = low complexity, low fluency; MCMF = moderate complexity, moderate fluency; HCHF = high complexity, high fluency; ** $p < .005$; *** $p < .001$.

Table 6

HCHF Subjective Self-Reports and Significant EEG Alpha Power Correlations

Variables	1	2	3	4	5	6	7	8	9
1. Flow***	1	.71***	.27***	.53***	.45***	.01	.10	-.06	.08
2. Concentration***		1	.31***	.64***	.48***	.12	.11	-.00	.08
3. Time Distortion***			1	.38***	.25***	-.14	-.04	.04	-.02
4. Activation***				1	.36***	.04	.12	.06	.05
5. Pleasantness					1	.09	.05	-.06	.03
6. HCHF_T3***						1	.49***	.54***	.51***
7. HCHF_T4***							1	.43***	.77***
8. HCHF_T5***								1	.72***
9. HCHF_T6***									1

Note. LCLF = low complexity, low fluency; MCMF = moderate complexity, moderate fluency; HCHF = high complexity, high fluency; ** $p < .005$; *** $p < .001$.

Experiment 1 Discussion

The purpose of Experiment 1 was to examine whether artworks of moderate complexity and conceptual fluency were more likely to evoke differences in psychophysiological markers of aesthetic experiences. Notably, the hypotheses were that: (H1) artworks appraised as “moderately complex and conceptually fluent” would elicit increased alpha activity across the brain (Ball et al., 2018; Commare, Rosenberg, & Leder, 2018; Graf, & Landwehr, 2017; Marin & Leder, 2016). Furthermore, as flow is a positively valenced state (Tian, Bian, Han, Wang, Gao, & Chen, 2017) participants were expected to report higher levels of flow and more positive affective states for the artworks of moderate complexity and conceptual fluency, in comparison to the artworks of low or high complexity and conceptual fluency (H2).

Subjective Self-Report Findings

The subjective data for Experiment 1 were statistically significant. Artworks appraised as highly complex and conceptually fluent led to higher subjective ratings of perceived levels of flow, concentration, time distortion, activation, pleasantness, aesthetic liking, complexity and conceptual fluency. First, the subjective dimensions of flow, concentration and time distortion involved measures adapted from the Core Dispositional Flow Scale and The Short Flow State Scale by Jackson, Eklund, & Martin (2008, 2010). These findings suggested that the HCHF category of images correspond to increased self-reported levels of flow, concentration and time distortion. According to previous research, it has been argued that a moderate level of conceptual fluency and complexity would lead to increased aesthetic liking and flow (Ball et al., 2018; Commare, Rosenberg, & Leder, 2018; Csikszentmihályi (1975; 2000; Graf, & Landwehr, 2017; Marin & Leder, 2016). In accordance to flow theory, proposed by Csikszentmihályi (1975; 2000) individuals should experience a balance between challenge and skill. The findings of the present study found that HCHF images led to increased self-reports of flow and aesthetic liking. Importantly, the dimensions of flow used in this research were relevant to observations of low, moderate, and high complexity and conceptually fluent artworks (i.e., level of challenge). Therefore, these findings may differ from the type of flow examined by Csikszentmihályi (1975, 2000), which suggests that a moderate level of challenge would evoke higher levels of positive affective states. Moreover, findings from this study might not echo previous research on flow, which has been mainly been conducted on sensori-motor rather than observational tasks (Tian et al., 2017).

Additionally, further explanations require consideration. The differential results of the present study (i.e., high complexity and high fluency artworks produced higher levels of self-reported levels of flow states) when viewed in relation to Csikszentmihályi’s (1975, 2000) flow theory, which purports that a moderate level of challenge would evoke higher levels of positive affective states, could have arisen from differences in theoretical frameworks and measurements in the present study. For example, Csikszentmihályi’s (1975, 2000) flow theory was based upon several domains, for example, creativity, education, and the workplace. He did not only study optimal states of performance in athletes. The commonality that Csikszentmihályi’s (1975, 2000) flow theory has with the present study on aesthetics of paintings is that the appraisal is an active, goal-oriented behaviour. It may be that the present study examined flow within a different (observational) context rather than the performance (sensory motor) context studied by Cikszentmihályi. Cikszentmihályi (1997) defined this different type of context as microflow. In other words, microflow pertains to activities that require a lower level of skill and challenge, and activities that are less intensive and complex. It could be that the HCHF categories of images were much lower in terms of skill and challenge balance than participants perceived. This may explain the differences in contexts of experiencing flow states and why there is a difference between the results of the present study and Csikszentmihályi's (1975, 2000) flow theory. It could be that within the context of viewing artworks, people are experiencing states of microflow.

Subjective Aesthetic Ratings

Contradictory findings of the literature based on aesthetic appreciation (i.e., aesthetic liking, complexity and conceptual fluency), have resulted from a multitude of theoretical and empirical problems (Van Geert & Wagemans, 2020). Noteworthy, differences in the measurements of complexity between studies have been found to influence beauty ratings (Nadal, Munar, Marty, & Cela-Conde, 2010). The categories of complexity and conceptual fluency in the present study were purely based upon subjective ratings, which was left completely up to the participants' interpretations and understanding in accordance with Ball et al's. (2018) research methodology. Due to the ratings being purely subjective, it might be that participants had a completely different interpretation of highly complex and highly meaningful than defined in the literature. Nadal et al. (2010) have found differences in the way that complexity and conceptual fluency have been defined, measured, manipulated and varied between studies. Importantly, Ball et al. (2018) used different methods of image categorization into low and high complexity categories and included five levels of categorization for conceptual fluency. Therefore, it could be possible that high complexity and high fluency image categories used in the present study were only part of the moderate complexity and conceptual fluency categories compared to those considered in previous work.

Additionally, it has been found that different types of images (i.e., snowflakes and solid objects; Adkins, & Norman, 2016) and texture patterns (Friedenberg & Liby, 2016) reveal positive linear relationships between complexity and aesthetic appreciation. The present study examined street art graffiti, which may have affected the participants' subjective reports of complexity and meaningfulness. On the other hand, Norman, Beers, and

Phillips (2010) found a non-inverted U-shaped relationship for solid objects. Both aspects such as the type of artwork and its complexity might affect aesthetic appraisals and subjective reports. Previous research has used different types of artworks, which may also affect interpretations of complexity, conceptual fluency and aesthetic liking. The nature of the stimuli used in the present study was graffiti street art, which may have affected participants' interpretations of complexity and conceptual fluency and can in turn affect aesthetic liking. The HCHF images were highly detailed. Additionally, the images in LCLF categories were simple, but they might have had deeper meanings that required art expertise to interpret, in which the participants in the present study may not have rated as meaningful. Moreover, the number of images (Corchs, Ciocca, Bricolo, & Gasparani, 2016) and the context of the artwork can also differ between studies (Marin & Leder, 2013). These differences might affect interpretations of complexity and conceptual fluency and therefore affect aesthetic liking ratings. Furthermore, the effects of complexity and conceptual fluency on aesthetic appreciation may be subject to individual differences (Güçlütürk, Jacobs, & Van Lier, 2016; Jacobsen & Höfel, 2002; Tinio, & Leder, 2009).

Moreover, the key area of debate in the existing literature pertains to the fact that studies do not generally agree upon the type and direction of the relationship between complexity, conceptual fluency and aesthetic liking (Adkins, & Norman, 2016; Friedenberg & Liby, 2016; Nadal, Munar, Marty, & Cela-Conde, 2010; Norman, Beers, & Phillips, 2010). Likewise, the correlation between complexity, conceptual fluency and aesthetic liking was moderate and positive. The findings from the present study coincide with previous research (Eysenck, 1942; see also Musinger & Kessen, 1964; Reber et al. 2004; Winkielman et al., 2003) suggesting that high-fluency (i.e., ease of deriving meaning) artworks may evoke positive affective states and influence aesthetic liking.

EEG Findings

The EEG data for Experiment 1 was statistically significant. Varied patterns of alpha power were found in electrodes T3, T5 and T6 across LCLF, MCMF and HCHF image categories. Furthermore, the varied patterns of alpha power found in the temporal lobe (T3, T5 and T6 electrodes) across LCLF, MCMF and HCHF image categories, likewise reflect specific functions. As mentioned in the introduction, alpha waves (8-10 Hz) within the context of actively appraising and viewing artworks is related to increased relaxation and engagement of attention, enhancing the processing of visual attributes (Cheung et al., 2014). Although alpha waves are a marker of relaxation and engagement of attention, there are also additional interpretations that exist. Alpha power in the temporal lobe is associated with many different functions of the visual system, such as memory encoding (Shourie et al., 2014), semantic associations (Lengger, Fischmeister, Leder, & Bauer (2007), emotion (Chatterjee, 2004) and meaning (Ratey & Galaburda, 2002). Previous research has suggested that there is an inversed relationship between alpha activity and cortical arousal. Therefore, increased alpha power reflects reduced cortical arousal and decreased alpha power reflects increased cortical arousal (Abraham, 2018; Benedek, & Fink, 2020; Gevins, Zeitlin, Doyle, Yingling, Schaffer, Callaway, & Yaeger, 1979; Mulholland, 1973; Mulholland & Runnals, 1962).

Alpha Power in EEG Electrode T3

Alpha activity in the T3 region indicated a U-shaped pattern. Alpha power was the highest during the viewing of HCHF, followed by LCLF and the lowest activity in MCMF image categories. Alpha power in the left temporal lobe, particularly in electrode T3 is related to visual perception and memory encoding, which comprises the ventral attention network (Khan, Martín-Montañez, & Baxter, 2011). Khan, Martín-Montañez, & Baxter, (2011) proposed that the ventral pathway within the temporal lobe is involved with identifying objects through shape and colour, which is also drawn upon in long-term memory. Previous research examining sensory motor tasks during the pre-shot phase of expert and novice marksmen have suggested that increased alpha power in the left temporal lobe, particularly in electrode T3 is related to verbal-analytical functions (Hatfield, Landers, & Ray 1984; Haufler, Spalding, Maria, & Hatfield, 2000; Kerick, Douglass, & Hatfield, 2003). This has not only been identified in sensory motor tasks, but also in tasks directly related to visual perception (Stevens, Kahn, Wig, & Schacter, 2012).

The results of the present study coincide with these findings. During the viewing of the HCHF image categories, participants may have been recruting less internal analytic or self-instruction strategies due to the nature of the HCHF image category being highly meaningful and clearly representing organic scenery (Ball et al., 2018). On the other hand, the LCLF and MCMF categories were more abstract in nature. Participants may have been recruiting their inner monologues or self-instruction strategies more to identify objects and derive meaning from the images. This is because the meaning derived from the LCLF and MCMF images was vague. These findings coincide with the proposal that alpha activity has been associated with bottom-up processing mechanisms in studies examining artists and non-artists (Bhattacharya, 2005; Bhattacharya, & Petsche, 2002). In this regard, Vogt and Magnussen (2005; 2007) have argued that artists and non-artists examine paintings differently. Artists use top-down processing by learning the illustrative aspects of a scene before categorizing or placing meaningful information towards it, whereas, non-artists use bottom-up processing by examining the meaning of the image first and then the perceptual details.

Alpha power in EEG Electrode T5

Alpha power in T5 revealed a reverse linear pattern. The highest activity was found in the LCLF image category, followed by MCMF and the lowest activity in HCHF. The left temporal lobe, particularly Wernicke’s area in T5 is involved primarily with speech and language comprehension (Beeman, & Chiarello, 1998). This region may be involved with processing speech related to visual information, meaning that visual information is being put into semantic categories from language (Hass-Cohen, & Carr, 2008; Hass-Cohen, & Loya, 2008). In the present study, alpha power may be increased in the LCLF image category because participants were using less resources to describe into words what they observed. The images were low in complexity and the meaning derived from the image was low, meaning that it may have been much more difficult to place these images into semantic categories because they were not as complex and not as meaningful as the HCHF images. Alpha power was the lowest in the HCHF image category, which may indicate that participants were using more resources to describe what they observed in words. This is because the highly complex and highly fluent category had more features that were able to be put into semantic categories. Furthermore, these findings are supported by Viskontas and Lee (2015), who proposed that patients with prosopagnosia are able to recognize an object but are unable to process the relationship between its features. Perhaps these functions are required to call upon these associations to identify objects.

Alpha Power in EEG Electrode T6

Alpha power in electrode T6 revealed a linear increasing pattern of activity. The highest alpha activity was found during the viewing of HCHF artworks, followed by MCMF and the lowest activity in LCLF images. The right temporal region is important in verbal, auditory and visual memory, interpreting the meaning of body language, words, object recognition and understanding social cues (Berninger, Abbott, Abbott, Graham, & Richards, 2002). This region may be related to the processing and understanding of the meaning of the images related to the visual perception of the artworks. Increased activity in T6 during the viewing of HCHF artworks may suggest that participants were recruiting less resources related to the visual memory associated with body language and social cues. Participants may not require this information because the meaning from the image could be easily derived. This is because it represented features of living beings, religious iconography, animals, and nature – and therefore memories of these familiar things – would already be stored in long-term memory. In the LCLF category, the alpha activity was lowest. This might mean that participants were working harder to process the meaning and understanding of the image. This might be due to the images being low in meaningfulness, which may indicate that a higher level of processing may have been required for the task. Therefore, participants recruited more activity to make sense of the less complex and less fluent images. Similarly, increased cortical activity in T6 during the viewing of LCLF artworks, has been found to be responsible for focused internal attention, inhibition of the ventral attention network and idea generation during creative thinking (Benedek, Schickel, Jauk, Fink, & Neubauer, 2014; Luft et al., 2018). This evidence suggests that during the viewing of LCLF artworks, participants required more focused attention to make more sense of the less complex and less fluent images.

Relationship Among Flow, Alpha Power, and Additional Subjective Self-Reports

In line with the theory of flow by Csikszentmihályi (1975, 2000), the correlation findings revealed that the self-reports of flow were positively correlated with concentration, time distortion, activation and pleasantness across all three image categories. Self-reports of flow during the LCLF condtion was weakley and positively correlated with alpha power in electrodes T3, T5 and T6. This suggests that, for the LCLF images only, increases in flow were coupled with increases in alpha power. It could be that task demands in the LCLF condition affected the participants' amount of brain activity in the temporal regions of the brain due to the amount of challenge experienced in the task. This may be due to the low complexity and low fluency category of images being more difficult to derive meaning from. Increased alpha might indicate reduced mental activity or cortical idling (Buzsáki &

Draguhn, 2004; Klimesch, Sauseng, & Hanslmayr, 2007; Ward, 2003). In addition, for the LCLF images, activation was positively correlated with pleasantness and alpha power in electrode T3. Alpha power has previously been related to pleasantness and activation whilst viewing pleasant and unpleasant video clips. It has been argued that greater attentional resources are associated with unpleasant stimuli (Sarlo, Buodo, Poli, & Palomba, 2005).

Overall, the findings of Experiment 1 do not support the hypotheses that propose moderately complex and conceptually fluent artworks would evoke increased subjective ratings. Furthermore, these results suggest that there is a linear increase within the subjective self-report ratings across LCLF, MCMF and HCHF categories. Moreover, different patterns of alpha activity across LCLF, MCMF and HCHF image categories arose in EEG channels T3, T5 and T6.

Experiment 2

Aims and Hypotheses

The key aim of Experiment 2 was to allow the participants to gaze at each image for a longer period of time in order to examine whether their first "gut feeling" impression differed from a reflective "second thought" impression. Each image was shown to the participants for a 16 second period, with the first 6 seconds representing the initial response time-window, and the subsequent 10 seconds (7^{th} to the 16^{th} second) representing the reflective response time-window. Methodologically, this 16 sec time window, and its respective initial and reflective time slots divisions, was established based on the findings of the pilot study, which revealed that in 95% of the trials, the participants spent, on average, a minimum of 5 and maximum of 15 seconds on any given image. Theoretically, this experimental manipulation is in line with the notion that complex, and less fluent visual stimuli take longer to be processed (Belke et al., 2010; Marin & Leder, 2016; Reber et al., 2004; Winkielman et al., 2003).

Overall, the purpose of Experiment 2 was to examine whether more viewing time of images of different complexities and conceptual fluency levels, would induce different levels of flow, concentration, time distortion, activation, pleasantness, aesthetic liking, conceptual fluency and complexity. Results of Experiment 1 revealed that HCHF categories of artworks elicited increased subjective self-reports of aesthetic liking, flow, concentration, time distortion, activation, and pleasantness. The EEG data revealed that there was an increase in alpha power in electrode sites (T3 and T6). The researcher proposed in the initial hypothesis for Experiment 1 that MCMF categories of artworks would elicit increased subjective reports and increased alpha power. This finding was not supported and therefore, the hypothesis for Experiment 2 were developed based on the findings of Experiment 1. It was hypothesised that HCHF artworks would elicit increased alpha and higher levels of concentration, time distortion and flow (H1). Conversely, HCHF artworks of high complexity would elicit increased levels of flow, concentration, and time distortion, in comparison to the paintings of low or moderate complexity and conceptually fluent images (H2).

Methods

Participants

In total, 16 participants were recruited through opportunity sampling of the general population. The sample involved 8 males and 8 females aged between 18-45 years old (M = 27.00, SD = 7.40). All of the recruitment methods and inclusion criteria were consistent with those employed in Experiment 1. The same rewards were used for Experiment 2 as in Experiment 1. Participants received either academic credits or Amazon vouchers in exchange for their participation. Ethical approval for this study was granted through the Psychology and Social Science Ethics Review Panel at the University of Central Lancashire (Appendix I).

Design

This experiment employed the same repeated measures design as described in Experiment 1. However, the design altered through the employment of a 2x3 factorial design. The two main independent variables were timing (6 seconds initial) and (10 seconds reflective) and complexity and conceptual fluency, categorised into three main groups (i.e., LCLF, MCMF and HCHF). The presentation of the images remained consistent with what was described in Experiment 1.

Experimental Task

This study consisted of a 2x3 repeated measures design. The independent variables were *timing,* which was categorised into “initial” (first 6 seconds of each trial) and “reflective” (7^{th} to the 16^{th} seconds of each trial) and *complexity and conceptual fluency*, categorised into three main groups (i.e., LCLF, MCMF and HCHF). The presentation of the images remained consistent with what was described in Experiment 1.

The same experimental task, images and total number of images were employed as in Experiment 1. However, the participants were given an imposed viewing time of 16 seconds in total per image (Figure 6). All the data collection procedures remained the same as was the case in Experiment 1.

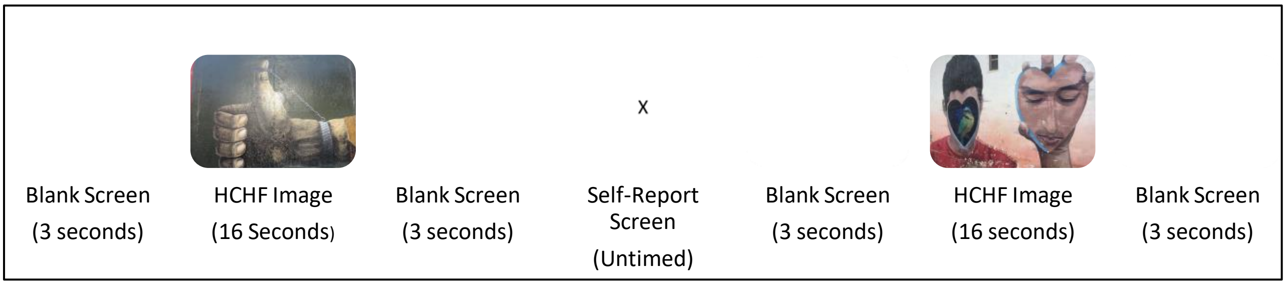

Figure 6. Schematic representation of the experimental task for Experiment 2.

Materials

Measures

Physiological and self-report measures remained the same as Experiment 1: alpha waves, flow-feeling, total concentration, time distortion, activation, pleasantness, aesthetic liking, conceptual fluency, and complexity. Additionally, a *two-response procedure* was included, in which participants were asked to provide two responses in accordance with aesthetic liking, conceptual fluency and complexity, as explained in more detail below.

Two-Response Procedure

A two-response procedure was recorded for aesthetic liking, conceptual fluency and complexity self-reports. Specifically, for each image, participants were asked to provide two separate ratings. Before the first rating (i.e., the initial response), participants were instructed to look at the image and think about their response very quickly to provide an initial impression after the image was presented for six seconds. The second rating (i.e., the reflective response) was provided after an additional 10 seconds of viewing time. Participants were told that this was their final impression and to think carefully about the image and reflect before this final rating. All responses were collected at the end of the presentation of each 16-second image to minimize movement artefacts from the EEG recording. For a more detailed description of the response procedure (see Appendix S).

Procedures

Participants were provided with a briefing (Appendix L) and consent form (Appendix M), which remained the same as the documents used in Experiment 1. Demographic information was recorded (Appendix N). The data collection procedure used for Experiment 2 remained the same as in Experiment 1 (i.e., baseline measures, low moderate and high complexity and conceptual fluency blocks and presentation format of all 27 images in total). The instructions (Appendix S) and experimental protocol (Appendix T) were referred to throughout the procedure and differed for Experiment 2. Participants were instructed regarding the two-response procedure and asked to think about their initial impression for aesthetic liking, complexity and conceptual fluency ratings during the first six seconds of image presentation. They were informed that there would not be a pause during this time and were asked to use the remaining 10 seconds to reflect and think more deeply about their first impressions. Afterwards, the experimenter would ask participants to provide two responses for *aesthetic liking, conceptual fluency* and *complexity* and recorded it onto a response sheet (Appendix U). The subjective report scales, as explained earlier in Experiment 1 remained the same for Experiment 2 (Appendix J). The duration of the experiment lasted approximately 2 hours. The debriefing remained the same as in Experiment 1, which explained the research hypotheses, theoretical background and participants were provided with an opportunity to ask questions (Appendix R).

Experiment 2 Results

Results for the subjective data analysis are presented first. Subsequently, the findings for the objective data are presented.

Subjective Measures

Means, standard deviations and *p*-values for the all subjective variables are presented in Tables 4 and 5, congruent with current APA guidelines (see Appelbaum et al., 2018). A 3 (LCLF, MCMF, HCHF) x 2 (Time; six seconds initial and 10 seconds reflective) repeated measures factorial ANOVA was conducted on the dependent variables *aesthetic liking, complexity* and *conceptual fluency*. A single repeated measures ANOVA across categories of images (LCLF, MCMF and HCHF) was conducted for *flow, concentration, time distortion, activation* and *pleasantness* subjective reports (see http://uclandata.uclan.ac.uk/id/eprint/206 for the full output file) as only one subjective rating was collected per image for these ratings. Post-hoc comparisons using the Bonferonni adjustment were conducted on the statistically significant results. Tests of within subjects contrasts were referred to so that the proper effect (i.e., linear or quadratic) could be identified.

Aesthetic Liking

There was a significant main effect for image category, $F(1.70, 242.97) = 32.96$, $p < .001$, $\eta_p^2 = .19$, thus confirming that the experimental manipulation was effective, as more complex and conceptually fluent images received higher aesthetic liking ratings. The HCHF image category received the highest self-report ratings of aesthetic liking. The main effect for timing was also significant, $F(1.00, 143.00) = 38.67$, $p < .001$, $\eta_p^2 = .21$, suggesting that there was a difference in aesthetic liking ratings during the initial and reflective timing assessments. The longer people were given to look at the paintings, the more the aesthetic liking ratings increased. The interaction effect between timing and image category was not significant, $F(1.22, 173.77) = .152$, $p = .747$, $\eta_p^2 = .00$. This suggests that there were no differences in aesthetic liking ratings in relation to a specific image category.

Conceptual Fluency

The main effects for image category was significant, $F(1.85, 264.35) = 78.36$, $p < .001$, $\eta_p^2 = .35$, thus confirming that the experimental manipulation worked, as more complex and conceptually fluent images received higher *conceptual fluency* ratings. The main effects for time revealed a significant difference, $F(1.00, 143.00) = 146.47$, $p < .001$, $\eta_p^2 = .51$, revealing that the participants’ *conceptual fluency* ratings increased between the initial and the reflective time windows. The interaction effect between timing and image category was significant, $F(2, 286) = 12.47$, $p < .001$, $\eta_p^2 = .08$, indicating that self-reports of conceptual fluency were the highest in the HCHF-R condition.

Complexity

The main effects for image category revealed significant results, $F(1.87, 266.75) = 79.06$, $p < .001$, $\eta_p^2 = .36$, confirming that the experimental manipulation was effective. The main effects of timing revealed a statistically significant result, $F(1.00, 143.00) = 80.29$, $p < .001$, $\eta_p^2 = .36$, as participants increased their complexity ratings from the initial to the reflective time windows. There was a significant interaction effect between image category and timing, $F(2, 286) = 5.38$, $p < .005$, $\eta_p^2 = .04$, suggesting that complexity ratings changed over time; In particular, the self-reports of complexity were the highest in the HCHF-R condition.

Table 7

Means and Standard Deviations Across LCLF-I, LCLF-R, MCMF-I, MCMF-R, HCHF-I and HCHF-R Subjective Data

Variables	LCLF-I		LCLF-R		MCMF-I		MCMF-R		HCHF-I		HCHF-R		ANOVA *F*		
	M	*SD*	M	*SD*	M	*SD*	M	*SD*	M	*SD*	M	*SD*	C-F	T	CFxT
Aesthetic Liking	4.07	2.33	5.15	5.39	5.19	2.18	6.07	2.49	6.33	1.85	7.32	1.85	32.96***	146.47***	12.47
Conceptual Fluency	23.28	19.59	28.55	23.16	35.63	20.72	47.36	24.58	48.19	21.99	61.67	23.30	78.36***	146.47***	12.47***
Complexity	28.75	21.83	34.51	22.21	44.51	19.99	52.50	20.33	53.13	20.87	64.31	22.71	79.06***	80.29***	5.38**

Note. LCLF-I = low complexity, low fluency initial; LCLF-R = low complexity, low fluency reflective; MCMF-I = moderate complexity, moderate fluency initial; MCMF-R = moderate complexity, moderate fluency reflective; HCHF-I = high complexity, high fluency initial; HCHF-R = high complexity, high fluency reflective; ** $p < .005$; *** $p < .001$.

Flow

A significant difference in self-reported experiences of *flow* across the LCLF, MCMF and HCHF conditions was revealed, $F(2, .286) = 45.19$, $p < .001$, $\eta_p^2 = .24$. As in Experiment 1, these results showed a linear increase in *flow* self-reports from the LCLF to the HCHF category. The highest subjective self-reports were found in the HCHF category.

Concentration

The results indicated a significant difference in self-reported levels of *concentration* across LCLF, MCMF and HCHF conditions, $F(1.94, 276.74) = 34.99$, $p < .001$, $\eta_p^2 = .20$. Similar to Experiment 1, these results revealed a linear increase in self-reported concentration throughout the LCLF, MCMF and HCHF categories. The highest self-reports of concentration were found in the HCHF category.

Time distortion

A significant effect of time distortion was revealed, $F(2, 286) = 29.10$, $p < .001$, $\eta_p^2 = .17$. These results revealed a linear increase of self-reported time distortion across the LCLF, MCMF and HCHF conditions. Self-reports of time distortion were the highest in the HCHF category of images.

Activation

The results revealed a significant difference in self-reported levels of activation throughout the LCLF, MCMF, HCHF, $F(2, 286) = 20.31$, $p < .001$, $\eta_p^2 = .12$. Similar to Experiment 1, the results indicated a linear increase in self-reported levels of activation across LCLF, MCMF and HCHF categories. Activation ratings were the highest in the HCHF category.

Pleasantness

A significant effect was observed for pleasantness, $F(1.92, 273.92) = 52.47$, $p < .001$, $\eta_p^2 = .27$. These results are consistent with the findings from Experiment 1 and indicate that participants experienced high levels of pleasantness in the HCHF condition, followed by the MCMF and the LCLF conditions, respectively.

Table 8

Means and Standard Deviations for Subjective Data Across LCLF, MCMF and HCHF

Variables	LCLF M (*SD*)	MCMF M (*SD*)	HCHF M (*SD*)	F (2, .286)	*p*	η_p^2	Post-Hoc
Subjective Data							
Flow***	5.08 (2.22)	6.19 (2.41)	6.60 (2.25)	45.19	.001	.24	LCLF<MCMF<HCHF
Concentration***	6.28 (1.92)	7.38 (1.76)	7.56 (1.91)	34.99	.001	.20	LCLF<MCMF<HCHF
Time Distortion***	4.47 (2.83)	5.41 (2.91)	6.25 (2.91)	29.10	.001	.17	LCLF<MCMF<HCHF
Activation***	5.60 (1.89)	6.43 (1.53)	6.57 (1.79)	20.31	.001	.12	LCLF<MCMF<HCHF
Pleasantness***	4.72 (2.13)	5.88 (2.01)	6.87 (1.63)	52.47	.001	.27	LCLF<MCMF<HCHF

Note. LCLF = low complexity, low fluency; MCMF = moderate complexity, moderate fluency; HCHF = high complexity, high fluency; ** $p < .005$; *** $p < .001$.

Objective Measures

Means, standard deviations and *p*-values for all objective variables are presented in Table 6 and Figure 2 below, akin to current APA guidelines (see Appelbaum, et al., 2018). A 2x3 factorial design was used. The two main independent variables were timing (6 seconds initial) and (10 seconds reflective) and complexity and conceptual fluency categories (i.e., LCLF, MCMF and HCHF) (see http://uclandata.uclan.ac.uk/id/eprint/206 for the full output file). The analysis was conducted on *alpha power* in all 19 EEG channels (see Figure 2 for a visual representation of the EEG data). In total, 16 seconds was allocated to the presentation of each image. An extra second was added onto the timings to consider the data processing procedures, which may cause lost time during data processing and segmentation (see Clayson et al., 2019; Teplan, 2002). Post-hoc comparisons using the Bonferonni adjustment were conducted on the statistically significant results. Tests of within subjects contrasts was referred to so that the proper effect (i.e., linear or quadratic) for alpha power activity could be identified.

Alpha Power

Table 6 presents the means, standard deviations and *F*-values for *alpha power* means for all 19 EEG channels in LCLF-I and LCLF-R; MCMF-I and MCLF-R; and HCHF-I and HCHF-R. Overall, the data displayed a mixture of patterns. There was a statistically significant main effect of the image category factor on *alpha power* in channels: T3 ($p < .005$), O1 ($p < .001$) and O2 ($p < .005$).

For T3 *alpha power* was decreased, and overall a significant decreasing trend across all three image categories. To be explicit, the highest *alpha power* was found in LCLF-R. This suggests that there was a significant main effect of image category and alpha power in T3, indicating the highest *alpha power* in the LCLF-R category. The experimenter conducted two different sets of post-hoc tests for image category and timing separately. The post-hoc tests for image category revealed a marginal statistically significant result between MCMF and HCHF (MCMF > HCHF, MD = 0.40, p = .048; MCMF > HCHF, MD = 0.53, p = .012). LCLF and HCHF (LCLF > HCHF, MD = -0.40, p = .048; LCLF > HCHF, MD = 0.23, p = .991) and LCLF and MCMF (LCLF > MCMF, MD = -0.53, p = .012; LCLF > MCMF, MD = -0.13, p = .991) image categories. The main effects of timing also revealed a statistically significant result in T3 ($p < .005$). Further post-hoc tests to compare the timings of the images were conducted by the researcher, which revealed a statistically significant result between initial and reflective timings (Initial < Reflective MD = -0.33, $p < .005$), (Reflective > Initial MD = 0.33, $p < .005$). The longer the viewing time, the higher the *alpha power* in T3. There were no significant interactions between image category and timing in electrode T3.

For O1, *alpha power* showed a significant increasing linear trend across the image categories overall. The highest *alpha power* was found in HCHF-R. There was a main effect of image category and *alpha power* in O1, which revealed the highest *alpha power* in the HCHF-R category. Post-hoc tests were conducted between MCMF and HCHF categories. Within the first comparison, no significant findings were found (MCMF < HCHF, MD = -0.23, p = .234). On the second comparison, a significant result was found (MCMF < HCHF, MD = -0.50, p <.001). Further post-hoc tests were run comparing LCLF and HCHF image categories, which did not reveal significant results (LCLF < HCHF, MD = 0.23, p = .234; (LCLF < HCHF, MD = -0.27, p = .137). The final test was conducted and compared LCLF with MCMF image categories and revealed a statistically signicant result (LCLF < MCMF, MD = 0.50, p <.001; LCLF < MCMF, MD = 0.27, p = .137). The main effects of timing revealed a statistically significant result in O1 ($p < .005$). Post-hoc tests were conducted, which revealed statistically significant results for both initial and reflective timings (Initial < Reflective, MD = -0.32, p <.005) (Reflective > Initial, MD = 0.32, p <.005). This means that longer the viewing time, the higher the *alpha power* in O1. There were no significant interactions between image category and timing in electrode O1.

For O2, alpha power revealed a significant increasing linear trend across the image categories. The highest *alpha power* was found in HCHF-R. A main effect of image category and *alpha power* was found in O2. Post-hoc tests were conducted between MCMF and HCHF categories, which revealed marginally significant findings (MCMF > HCHF, MD = -0.47, p = .015; MCMF > HCHF, MD = -0.54, p = .006). Further post-hoc tests were carried out to compare LCLF and HCHF image categories, which only revealed one marginally significant result and a result that was not statistically significant (LCLF > HCHF, MD = 0.47, p = .015; LCLF > HCHF, MD = -0.07, p = 1.00). The final post-hoc comparison was carried out which indicated a marginally statistically significant finding and a result that was not statistically significant (LCLF > MCMF, MD = 0.54, p = .006; LCLF > MCMF, MD = 0.74, p = 1.00). These findings revealed that the highest *alpha power* was found in the HCHF category of images. There were no significant main effects for timing in electrode O2. Additionally, there were no significant interaction effects between image category and timing in electrode O2.

Additionally, there was a statistically significant main effect of the timing factor in all channels except for Fp1, F7, F8, T4, Pz and O2. There were no significant interaction effects between image category and timing within any of the EEG electrodes. This suggests that there are differences in the neural patterns implicated between initial and reflective aesthetic appraisals of graffiti street art.

For a more detailed visual representation of alpha power in all 19 EEG channels see Figure 8, which displays heat maps of absolute alpha power means. The heat maps display lowest alpha power activity in blue, the highest alpha power in red and average in green.

Table 9

Alpha Power Across LCLF-I, LCLF-R, MCMF-I, MCMF-R, HCHF-I and HCHF-R Categories of Images

	LCLF-I		LCLF-R		MCMF-I		MCMF-R		HCHF-I		HCHF-R		ANOVA *F*		
	M	*SD*	M	*SD*	M	*SD*	M	*SD*	M	*SD*	M	*SD*	C-F	Timing(T)	CFxT
Fp1	8.56	4.94	8.11	3.85	8.04	4.89	9.60	5.94	7.92	4.56	8.79	4.88	1.14	5.91	5.02
Fp2	8.07	3.65	8.57	3.82	8.41	4.37	9.50	4.83	7.89	3.67	8.89	4.36	2.60	11.80***	0.80
F7	5.96	2.34	6.04	2.71	6.00	2.67	6.24	2.72	5.71	2.47	5.79	2.54	2.87	0.81	0.23
F3	5.77	2.37	6.55	3.30	5.68	2.72	6.60	3.42	5.82	2.92	6.63	3.81	0.10	20.47***	0.10
Fz	6.32	2.89	6.98	3.53	6.30	3.31	7.36	3.93	6.46	3.48	7.23	4.00	0.55	20.74***	0.68
F4	6.40	2.65	7.39	3.77	6.60	3.38	7.54	3.75	6.41	3.31	7.22	3.71	0.53	20.46***	0.12
F8	6.12	1.95	6.32	2.42	6.20	2.94	6.52	2.65	5.73	2.01	6.61	3.27	0.46	7.91	2.14
C3	4.24	1.87	4.76	2.81	4.10	2.22	4.81	2.99	3.93	1.98	4.74	2.98	0.78	17.00***	0.70
Cz	4.83	2.09	5.64	2.86	4.97	2.12	5.77	2.81	4.94	2.06	5.77	3.01	0.39	25.77***	0.01
C4	5.35	2.69	6.17	3.34	5.02	2.44	5.55	2.71	4.99	2.57	5.89	3.50	2.60	25.72***	0.81
T3	3.91	2.03	4.22	2.12	3.60	2.07	3.73	1.81	3.26	1.51	3.82	1.89	6.03**	10.09**	1.88
T4	3.81	1.76	3.72	1.60	3.45	1.41	3.74	1.58	3.45	1.43	3.81	1.84	1.15	5.43	3.56
T5	2.63	1.30	3.05	1.67	2.47	1.05	3.00	1.30	2.38	1.12	2.95	1.43	1.72	35.46***	0.42
T6	3.12	2.09	3.43	2.27	3.01	2.11	3.24	2.00	2.79	1.78	3.52	2.43	1.18	30.39***	3.59
P3	3.57	1.63	3.70	1.77	3.50	1.31	3.64	1.24	3.40	1.24	4.12	2.58	0.97	10.04**	3.39
Pz	4.40	1.70	4.77	2.27	4.50	1.80	4.54	1.56	4.20	1.32	4.89	2.49	0.08	7.33	2.74
P4	4.39	2.15	4.88	2.48	4.27	2.16	4.73	2.30	4.05	1.86	4.80	2.56	1.10	27.33***	0.87
O1	2.86	1.40	3.37	1.94	3.24	1.57	3.44	1.56	3.48	1.97	3.74	1.92	7.23***	9.20**	1.18
O2	3.49	2.31	3.74	2.28	4.04	2.77	4.12	2.46	3.91	2.47	4.40	2.72	5.58**	5.47	0.78

Note. LCLF-I = low complexity, low fluency initial; LCLF-R = low complexity, low fluency reflective; MCMF-I = moderate complexity, moderate fluency initial; MCMF-R = moderate complexity, moderate fluency reflective; HCHF-I = high complexity, high fluency initial; HCHF-R = high complexity, high fluency reflective; ** $p < .005$; *** $p < .001$; μV^2 = microvolts squared. C-F = Conceptual Fluency.

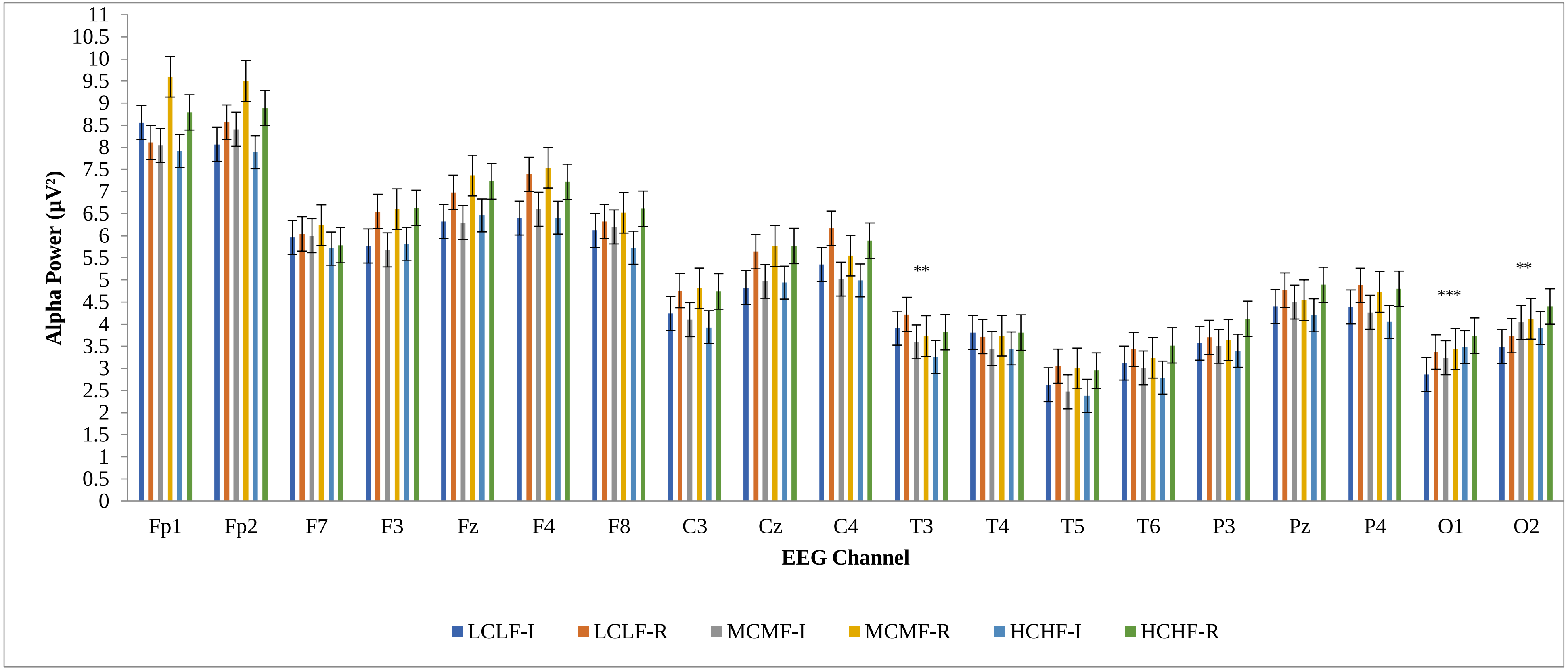

Figure 7. Alpha power (μV²) across all 19 EEG channels during the viewing of LCLF-I, LCLF-R, MCMF-I, MCMF-R, HCHF-I and HCHF-R image categories.

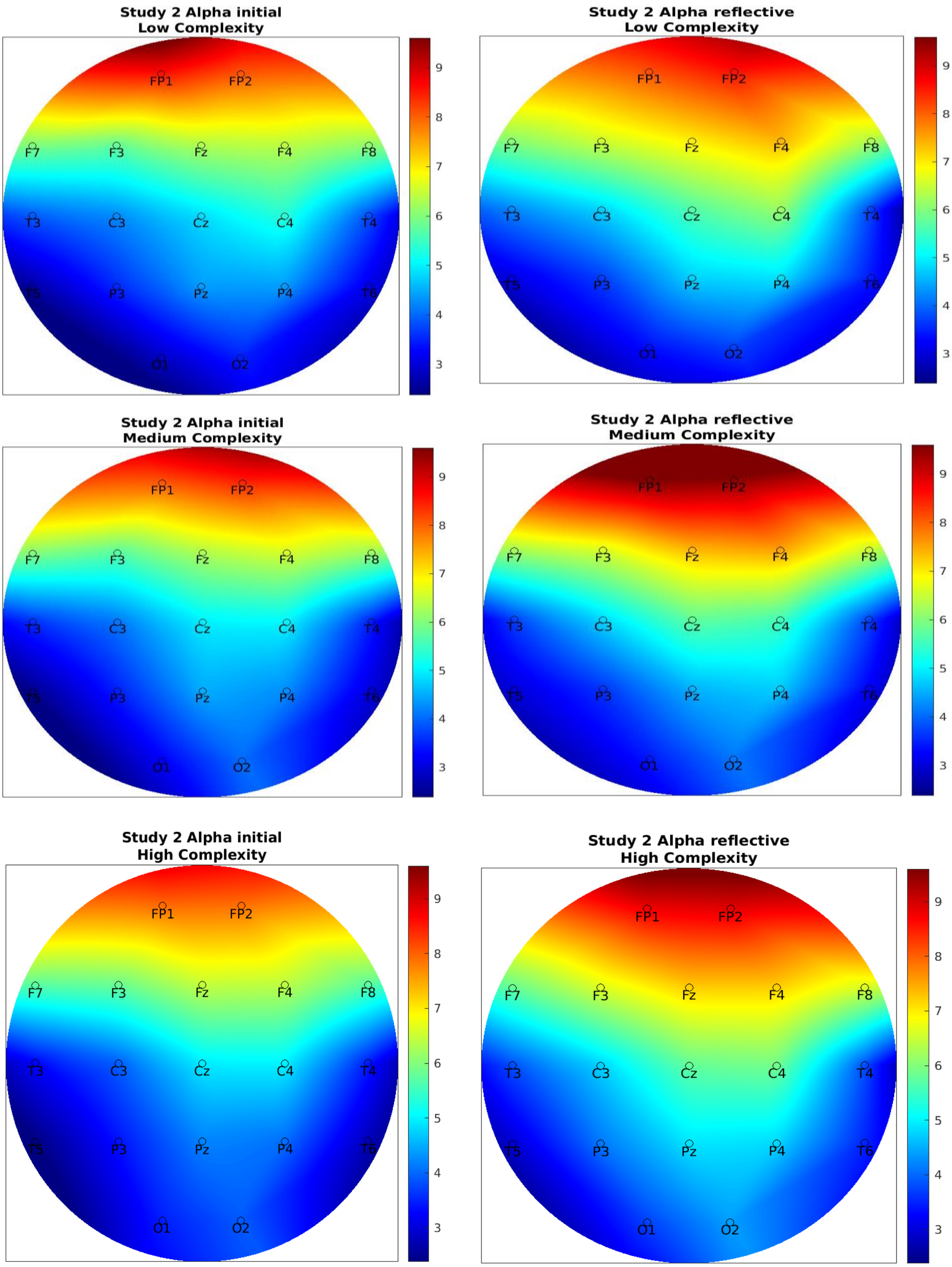

Figure 8. Heat maps of alpha power (μV²) (ranging from 2.38 (lowest in blue) to 9.60 (highest in red) across all 19 EEG channels during the viewing of LCLF-I (top left), LCLF-R (top right), MCMF-I (middle left), MCMF-R (middle right), HCHF-I (bottom left) and HCHF-R (bottom right) image categories.

Correlations

Pearson correlations between subjective self-reports and the statistically significant EEG electrodes were conducted to examine the relationship between the subjective and objective variables (see Tables 7, 8 and 9). For image categories LCLF and MCMF, flow was positively correlated with concentration, time distortion, activation and pleasantness. For the HCHF image category, flow was positively correlated with concentration, time distortion and activation. Across all three image categories, concentration was positively correlated with time distortion, activation, and pleasantness ($.25 < r > .66$). There was a positive correlation between all EEG channels across all three image categories.

For the LCLF image category, the relationship between flow and concentration ($r = .51$, $p < .001$), flow and time distortion ($r = .65$, $p < .001$), flow and activation ($r = .52$, $p < .001$), and flow and pleasantness ($r = .58$, $p <.001$) were moderate positive linear relationships. This relationship indicated that as the subjective reports of flow increased, the self-reports of concentration, time distortion, activation and pleasantness increased at the same time. There were no significant findings of a relationship between flow and alpha power.

In the MCMF image category, the relationship between flow and time distortion ($r = .65$, $p < .001$), flow and activation ($r = .53$, $p < .001$), and flow and pleasantness ($r = .63$, $p < .001$) were all a moderate positive linear relationship. The correlation between flow and concentration was a weak positive linear relationship ($r = .25$, $p < .001$). This suggests that as flow self-reports increased, self-reports of time distortion, activation and pleasantness also increased. No significant findings of a relationship between flow and alpha power were found.

Within the HCHF image category, the relationship between flow and concentration ($r = .32$, $p < .001$) was a weak positive linear relationship. Correlations between flow and time distortion ($r = .66$, $p < .001$), and flow and activation ($r = .40$, $p < .001$) were a moderate positive relationship. These findings show that as subjective self-reports of flow increased, the self-reports of concentration, activation and time distortion increased. There were no significant findings of a relationship between flow and pleasantness. Additionally, no significant findings of a relationship between flow and alpha power throughout EEG electrodes T3, T5 and T6 in the HCHF category of images.

Table 10

LCLF Subjective Self-Reports and Significant EEG Alpha Power Correlations

Variables	1	2	3	4	5	6	7	8	9	10	11
1. Flow***	1	.51***	.65***	.52***	.58***	-.07	-.11	.03	.02	.04	-.30
2. Concentration***		1	.51***	.67***	.26***	.09	.09	-.11	-.06	.06	-.05
3. Time Distortion***			1	.46***	.33***	-.03	-.06	-.01	.07	-.01	-.07
4. Activation***				1	.43***	.09	.05	-.04	-.09	.12	-.05
5. Pleasantness***					1	-.13	-.16	.12	.01	.07	-.01
6. LCLF-I_T3***						1	.64***	.12	.15	.21**	.25**
7. LCLF-R_T3***							1	.15	.28***	.30***	.39***
8. LCLF-I_O1***								1	.69***	.83***	.54***
9. LCLF-R_O1***									1	.62***	.74***
10. LCLF-I_O2***										1	.62***
11. LCLF-R_O2***											1

Note. LCLF-I = low complexity, low fluency initial; LCLF-R = low complexity, low fluency reflective; MCMF-I = moderate complexity, moderate fluency initial; MCMF-R = moderate complexity, moderate fluency reflective; HCHF-I = high complexity, high fluency initial; HCHF-R = high complexity, high fluency reflective; ** $p < .005$; *** $p < .001$.

Table 11

MCMF Subjective Self-Reports and Significant EEG Alpha Power Correlations

Variables	1	2	3	4	5	6	7	8	9	10	11
1. Flow***	1	.25***	.65***	.53***	.63***	-.08	-.06	.05	-.04	-.01	.08
2. Concentration***		1	.35***	.44***	.18**	.13	.14	-.02	-.04	.03	.11
3. Time Distortion***			1	.44***	.34***	.08	.07	.08	.11	.05	.14
4. Activation***				1	.46***	.08	-.02	.01	-.09	.00	.10
5. Pleasantness***					1	-.03	-.09	-.03	-.17	.02	-.01
6. MCMF-I_T3***						1	.70***	.20**	.31**	.40***	.35***
7. MCMF-R_T3***							1	.22**	.29***	.36***	.28***
8. MCMF-I_O1***								1	78***	.85***	.78***
9. MCMF-R_O1***									1	.65***	.82***
10. MCMF-I_O2***										1	.83***
11. MCMF-R_O2***											1

Note. LCLF-I = low complexity, low fluency initial; LCLF-R = low complexity, low fluency reflective; MCMF-I = moderate complexity, moderate fluency initial; MCMF-R = moderate complexity, moderate fluency reflective; HCHF-I = high complexity, high fluency initial; HCHF-R = high complexity, high fluency reflective; ** $p < .005$; *** $p < .001$.

Table 12

HCHF Subjective Self-Reports and Significant EEG Alpha Power Correlations

Variables	1	2	3	4	5	6	7	8	9	10	11
1. Flow***	1	.32***	.66***	.40***	.14	.10	.00	-.04	-.04	-.15	-.09
2. Concentration***		1	.32***	.56***	.45***	-.037	.00	-.05	-.04	-.16	-.00
3. Time Distortion***			1	.36***	.26***	.12	-.02	-.07	-.14	-.17	-.16
4. Activation***				1	.43***	.03	.02	.03	.05	.02	.01
5. Pleasantness***					1	-.03	-.13	-.13	-.18	-.13	-.06
6. HCHF-I_T3***						1	.66***	.29***	.30***	.38***	.30***
7. HCHF-R_T3***							1	.15	.37***	.38***	.44***
8. HCHF-I_O1***								1	.60***	.77***	.45***
9. HCHF-R_O1***									1	.67***	.80***
10. HCHF-I_O2***										1	.69***
11. HCHF-R_O2***											1

Note. LCLF-I = low complexity, low fluency initial; LCLF-R = low complexity, low fluency reflective; MCMF-I = moderate complexity, moderate fluency initial; MCMF-R = moderate complexity, moderate fluency reflective; HCHF-I = high complexity, high fluency initial; HCHF-R = high complexity, high fluency reflective; ** $p < .005$; *** $p < .001$.

Experiment 2 Discussion

Overall, the purpose of Experiment 2 was to expand upon the findings of Experiment 1 and include the aspects of initial and reflective viewing time (i.e., whether more or less viewing time would affect self-reported subjective ratings of flow, concentration, time distortion, activation, pleasantness, aesthetic liking, conceptual fluency and complexity). It was hypothesised that HCHF artworks would elicit increased alpha and higher levels of concentration, time distortion and flow (H1). Conversely, HCHF artworks of high complexity would elicit increased levels of flow, concentration, and time distortion, in comparison to the paintings of low or moderate complexity and conceptual fluency (H2).

The main effects of conceptual fluency and timing were significant in conceptual fluency and complexity. Furthermore, there was a significant interaction effect between conceptual fluency and complexity, indicating that increased viewing time led to increased ratings in the HCHF-R condition. In regard to the objective EEG data, there were significant main effects of alpha power in channels T3, O1 and O2.

Subjective Self-Report Findings

Experiment 2 reinforced the findings of subjective data in Experiment 1, which revealed that the HCHF category of images led to increased subjective ratings of flow, concentration, time distortion, activation, pleasantness, aesthetic liking, complexity and conceptual fluency. Additionally, the longer the viewing time, the more the aesthetic liking, complexity and conceptual fluency ratings increased as well as more positively valenced affective states.

EEG Findings

The EEG results of Experiment 2 found significant main effects of image category in channels T3, O1 and O2.

Alpha Power in EEG Electrode T3

Noteworthy, the pattern of alpha power found in electrode T3 in Experiment 2 differed from the findings in Experiment 1. While alpha power remained low in this site, the highest activity was found in LCLF-R in electrode T3. As previously stated (see the Discussion section for Experiment 1), increased activity in T3 has been related to verbal analytical functions during visuomotor tasks (Hatfield, Landers, & Ray 1984; Haufler, Spalding, Maria, & Hatfield, 2000; Kerick, Douglass, & Hatfield, 2003). Additionally, it has been related to the ventral attention network, which is implicated in visual perception and long-term memory encoding related to object identification (Khan, Martin-Montanez, & Baxter, 2011). These results might be explained due to the nature of the artworks shown in the LCLF category. These images were more abstract and were rated as less complex and less conceptually fluent. Previous research has revealed that this type of visual stimuli takes longer to be processed (Belke et al., 2010; Marin & Leder, 2016; Reber et al., 2004; Winkielman et al., 2003). Therefore, it could be with the increased time that the participants had to make an appraisal, alpha activity in the LCLF-R category increased due to participants searching for the encoded information in their memory.

As a result of more time to process the information and search for it in their memory, participants were recruiting less cortical activity in the LCLF-R category of images. As mentioned previously in the Discussion section for Experiment 1, it has been noted that non-artists focus their attention most on interpreting the meaning of the image first (Vogt, & Magnussen, 2007). As these images are low in fluency, the meaning of the images may take a lot longer to process for participants who are not artists. Additionally, Forster, Fabi, and Leder (2015) revealed that the subjective feelings of fluency can be influenced by duration of image presentation and ease of processing. The longer image presentations affected ratings of self-reported fluency of the images. Furthermore, Gerger, Forster, and Leder (2017) found that longer image presentations increased ratings of higher fluency, and positively affected aesthetic liking appraisals in abstract patterns. It could be that less recruitment of analytical internal monologues was required due to the increased amount of time provided to view each image.

Alpha Power in EEG Electrodes O1 and O2

The findings of increased alpha power in O1 and O2 during the viewing of HCHF-R image categories may be explained by recruitment of the ventral attention network to reduce distractions (Jensen and Mazaheri 2010; Jung-Beeman et al., 2004; Kawabata and Zeki, 2004; Loze, Collins, & Holmes, 2001). These findings suggest that in the HCHF-R category of images, there is more information to attend to for a longer amount of time, which therefore leads participants to recruit less cortical activity. These findings are illustrated by Zumer, Scheeringer, Schoffelen, Norris, and Jensen (2014) who found that alpha activity in the occipital lobe is related to sensory gating of information from the visual cortex to the ventral attention network, which leads to selective attention during stimulus processing. Due to the nature of the HCHF images being highly complex, detailed, and highly meaningful, participants may have been reducing visual distractions. In particular, the occipital regions, electrodes O1 and O2 are part of the visual cortex and have been associated with processing colour, inhibition, memory and emotion (Konston et al., 2015). It may be a possibility that the visual pathways were being suppressed to limit visual distractions during the HCHF-R image category.

Correlation Findings

Regarding the correlations between LCLF and MCMF image categories, self-reports of flow were positively correlated with concentration, time distortion, activation and pleasantness. For the HCHF image category, flow was positively correlated with concentration, time distortion and activation. Across all three image categories, concentration was positively correlated with time distortion, activation and pleasantness. These findings coincide with the notion of microflow states proposed by Csikszentmihályi (1998) which suggests that subjective self-reports of flow are are associated with concentration, time distortion, activation and pleasantness. There were no correlations between flow and alpha power activity in any of the electrodes. As previously discussed in relation to Experiment 1, this might be because of the categorization of the images.

General Discussion

The purpose of Experiment 1 was to examine whether artworks of moderate complexity and conceptual fluency were more likely to induce psychophysiological markers of aesthetic experiences. The hypotheses were that: (H1) artworks appraised as "moderately complex and conceptually fluent" would elicit increased alpha activity across the brain (Berlyne, 1971; Marin & Leder, 2016; Munsinger & Kessen, 1964; Vitz, 1966). Furthermore, as flow is a positively valenced state (Tian, Bian, Han, Wang, Gao, & Chen, 2017), participants were expected to report higher levels of flow and more positive affective states for the artworks of moderate complexity and conceptual fluency, in comparison to the artworks of low or high complexity and conceptual fluency (H2). The findings of Experiment 1 revealed that HCHF categories of artworks elicited greater self-reports of flow, more positive affective states and increased alpha power. These findings therefore changed the hypotheses for Experiment 2 to maintain consistency.

The purpose of Experiment 2 was to examine whether increased viewing time of images of different complexities and conceptual fluency levels would induce different levels of flow, concentration, time distortion, activation, pleasantness, aesthetic liking, conceptual fluency and complexity. It was hypothesised that HCHF artworks would elicit increased alpha and higher levels of concentration, time distortion and flow (H1). Conversely, HCHF artworks of high complexity would elicit increased levels of flow, concentration and time distortion, in comparison to the paintings of low or moderate complexity and conceptually fluent images (H2).

Self-Reported Psychological States

In both Experiments 1 and 2, subjective self-reports of psychological states (i.e., flow, concentration, time distortion, activation and pleasantness) revealed the same linear increasing pattern across LCLF, MCMF and HCHF images categories, with HCHF images having the highest self-reports from each measure. These findings are supported by Csikszentmihályi's (1998) microflow theory, which purport that within lower intensities of activities (i.e., context of actively viewing art), flow states can still be experienced within individuals with a lower amount of skill at lower intensities. The intensity of the activities (i.e., actively viewing art) as oppose to performance contexts (i.e., sensory motor tasks) may not be the same. However, it is important to note that these activities are both goal-oriented and are active processes. Likewise, Csikszentmihályi and Robinson (1990) proposed that there are links between aesthetic experiences and flow states, in which concentration and a distorted sense of time may occur. However, it is important to note that there is a main aspect of flow theory which does not support the findings of the present experiment. That is, Csikszentmihályi and Robinson (1990) proposed that moderately challenging stimuli may affect aesthetic liking and induce flow-feeling experiences. In the case of the present two experiments, the subjective feelings of flow were most experienced in the HCHF image category.

Subjective Report Correlations

The correlations of the subjective reports coincide with the theory of flow by Csikszentmihályi (1975, 2000). The findings revealed that the self-reports of flow were positively correlated with concentration, time distortion, activation and pleasantness across all three image categories in both Experiments 1 and 2. Additionally, the findings in

Experiments 1 and 2 coincide with the notion of microflow states proposed by Csikszentmihályi (1998), which suggests that subjective self-reports of flow are positively correlated with each measurement of concentration, time distortion, activation and pleasantness, particularly in the HCHF image categories.

Goller, Mitrovic, and Leder (2019) examined the relationship between liking and visual attention in faces and paintings. The results confirmed a linear link between liking and visual attention. Thus, the more a person likes a painting the more they are likely to pay attention at it and perhaps experience flow and its characteristics, such as time distortion and positive affect. More recently, studies have evaluated Berlyne's (1971) *Inverted-U Hypothesis* in more depth through reviews and meta-analytic studies. The findings from Marin, Lampatz, Wandi, and Leder (2016) are in line with the findings of the present study. It was found that the relationship between complexity and liking was positively correlated. Moreover, the findings from the present study are congruent with research by Hayn-Leichsenring, Lehmann, and Redies (2017) who found a positive relationship between subjective ratings of aesthetic liking and beauty.

Subjective Ratings of Complexity and Conceptual Fluency

In addition, differences in the measurements of complexity between studies have been found to influence beauty ratings (Nadal, Munar, Marty, & Cela-Conde, 2010). Various methods of definitions, measurements, manipulations of complexity and conceptual fluency have been used between studies (Ball et al., 2018; Nadal et al., 2010). Noteworthy, this project has examined only three levels of complexity and conceptual fluency. There might be additional categories of the images that have not been identified or explored. Previous research has found that the type of image may also affect interpretations of complexity, conceptual fluency and aesthetic liking (Adkins, & Norman, 2016; Friedenberg & Liby, 2016). The nature of the stimuli used in the present study, which was graffiti street art, may have affected interpretations of complexity and conceptual fluency, which in turn affects aesthetic liking. Similarly, the number of images and context may also vary between studies (Corchs, Ciocca, Bricolo, & Gasparani, 2016; Marin & Leder, 2013). Furthermore, individual differences between artistic preferences and tastes may further affect self-report ratings (Güçlütürk, Jacobs, & Van Lier, 2016; Jacobsen & Höfel, 2002; Tinio, & Leder, 2009). These aspects highlight key areas of debate within the existing literature and explain why studies do not agree with the type and direction of the relationship between complexity, conceptual fluency and aesthetic liking.

Furthermore, the findings of Experiment 1 and 2, suggesting that HCHF images were more liked and thus more interesting, coincide with previous research suggesting that high-fluency artworks may evoke positive affective states and influence aesthetic liking (Ball et al., 2018, Musinger & Kessen, 1964; Reber et al. 2004; Winkielman et al., 2003). Additionally, Ball et al. (2018) suggests that the higher the conceptual fluency of the image (i.e., ease of processing), the more the artwork will be aesthetically pleasing and thus positively affect aesthetic liking ratings. This explanation coincides with the findings of the present study. The HCHF image category was more easily processed and thus self-reports indicated a linear increase in all subjective variables (i.e., aesthetic liking, flow, concentration, time distortion, activation and pleasantness). Moreover, the higher subjective reports observed for the HCHF images corroborate Graf and Landwehr’s (2015) PIA Model. It could be interpreted that HCHF images led to higher subjective ratings. However, the EEG results highlight different findings, as discussed next.

Experiment 1 – Alpha Power Changes

The findings of the present study, which revealed different patterns for alpha power in the temporal lobe, may be explained by the *Neuropsychological Model of Aesthetic Preference,* proposed by Chatterjee (2004). This model suggests that during the visual processing of artwork, the attentional networks in the ventral visual stream are related to attributional networks in which meaning is being processed (Kravitz, Saleem, Baker, Ungerleider, & Mishkin, 2013). These attentional and attributional networks are then linked when an appraisal is being made, which exhibits increased activity in the temporal lobes (Chatterjee, 2004). Additionally, the medial temporal lobe, medial and orbito cortices and subcortical structures are involved with the emotional systems triggered during aesthetic appraisals (Chatterjee & Vartanian, 2014). The findings of the current study may offer support to the notion that images of high complexity and fluency (HCHF) are perceived as more interesting, and thus led to increased alpha power in the temporal lobes compared to the other two image categories. The visual aspects may be identified in the cognitive and emotional networks related with visual processing.

Additionally, findings from Lengger, Fischmeister, Leder, and Bauer (2007) support the findings of increased brain activity in the temporal lobes. The ventral pathway is related to the visual system. Furthermore, Lengger et al.'s (2007) results may explain the findings of increased alpha power in EEG channels T3 and T5. The findings suggest that increased alpha activity in the temporal lobes may be related to suppression of object recognition and memory associations. Moreover, Luft et al. (2018) and Schiferl (2008) support the findings of increased alpha power in EEG channel T4 and T6 located in the right temporal lobe. This has been previously associated with inhibiting and blocking out distractions and obvious semantic associations during visual searches of problem-solving tasks, which has been argued to facilitate creative problem solving.

Experiments 1 and 2 EEG Correlations

The self-reports of flow were positively correlated with alpha power in LCLF image categories in electrodes T3, T5 and T6. The findings in the present study suggest that HCHF images are related to increased self-reports of flow, concentration, time distortion, activation and plesantness. However, the correlations suggest that self-reports of flow and alpha power increased only in the LCLF image categories in electrodes T3, T5 and T6. An explanation for this difference in the data might arise from The Default Mode Network proposed by Belfi, Vessel, Brielmann, Isik, and Chatterjee (2019; Cela-Conde, García-Prieto, Ramasco, Mirasso, & Bajo, 2013; Vessel, Starr, & Rubin, 2012; Raichle, 2015) which suggests that there is a set of active brain regions when a person is not focused on the outside world. These findings suggest that less alpha activity may be related to tasks that require increased amounts of cognitive effort. In accordance with flow theory proposed by Csikszentmihályi (1975, 2000) perhaps the LCLF images were more challenging to process for the participants and therefore revealed varied patterns of alpha activity in each image category.

The correlations between the subjective reports of flow states (i.e., flow, concentration, time distortion, activation, and pleasantness) were all positively correlated in both Experiments 1 and 2. Furthermore, in Experiment 1, LCLF images were weakly positively correlated with flow states. This finding coincides with Csikszentmihályi (1998) who suggested that microflow may be experienced at the level of a novice, during goal-oriented activities, such as appraising artworks. This has been argued to be experienced within a lower threshold of balance between challenge and skill. The correlations between the subjective reports of flow states were not correlated to alpha power activity in any other image category. It could be that the LCLF image categories were encouraging people to engage with the artworks more than the HCHF image categories. In addition, alpha waves have been associated with a relaxed and alert mental state (Roohi-Azizi, Azimi, Heysieattalab, & Aamidfar, 2017), which may explain the findings of different patterns of increased and decreased alpha power, as discussed in the next section.

Experiment 2 – Alpha Power Changes

EEG brain activity revealed significant differences across a large magnitude of alpha power activity, across the frontal (Fp2, F3, Fz, F4) central (C3, Cz, C4), temporal (T3, T5, T6), pariental (P3, P4) and occipital (O1 and O2) lobes.

Changes of alpha activity in the frontal lobes, particularly in channels Fp2, F3, Fz and F4 might be linked to the processing of visual information. These findings coincide with those of Chatterjee's (2004) *Neuropsychological Model of Aesthetic Preference*. The attentional processes travel through the frontal-parietal networks and redirect the information to the primary visual properties (i.e., colour, shape and composition). The visual cortex is involved with visual processing in the frontal areas and is also related to emotional expression and aesthetic judgments. The findings of Experiment 2 are similar to the findings of Konston, Megjhani, Brantley, Cruz-Garza, and Nakagome (2015) who observed increased alpha activity in the frontal areas of the brain during aesthetic judgments. Additionally, the findings of the current study coincide with research showing that increased activity in the left dorsolateral pre-frontal cortex occurs when individuals view beautiful stimuli (Cela-Conde, Marty, Maestú, Ortiz, Munar, Fernández, Roca, Rosselló, & Quesney, 2004; Kawabata & Zeki, 2004; Vartanian and Goel 2004). These findings build upon previous work by examining varying levels of complexity and conceptual fluency in artworks in relation to different patterns of alpha power.

Alpha in the Occipital Lobe

The observed increased alpha activity in the occipital regions coincide with those of Kawabata and Zeki (2004), who found increased activation in the occipital regions when individuals gazed at both beautiful and ugly paintings. The occipital regions V4 and V5 are part of the visual cortex and are involved with processing the colour of both beautiful and ugly stimuli. Moreover, the findings of Experiment 2 are in line of those reported by Vartanian and Goel (2004), who observed that aesthetic preference is linked to increased bilateral activity in the occipital regions, related to increased activity in the visual cortex. Indeed, increased activity in occipital areas has been related to visual processing, as well as inhibition, memory and emotion (Konston et al., 2015). Furthermore, both the occipital and temporal lobes have been related to colour knowledge and meaning (Miceli, Fouch, Capasso, Shelton, Tomaiuolo, & Caramazza, 2001) Additionally, Jensen and Mazaheri 2010; Jung-Beeman et al., 2004) found that increased alpha EEG activity during problem solving is related to idling and inhibition of the visual pathways to limit visual distractions. It may be that during the viewing of HCHF image categories, increased alpha activity revealed reduced cortical arousal, which means that participants were more relaxed. There may have been too much to attend to within the HCHF images, as they were highly complex. This may may have resulted in the inhibition of the visual pathways to limit visual distractions.

Alpha in the Central Lobe

Changes of alpha activity in the central lobe may be explained by the findings of Parr, Vine, Wilson, Harrison, and Wood (2019) who suggest that less alpha activity in the central areas are related to inhibitory control, in which the resources are diverted away from brain regions via a gating mechanism, showing higher alpha power (i.e., more inhibition) and lower alpha power (i.e., lower inhibition). This has been argued to be involved with visual attention and increasing conscious control related to the initial and reflective timings.

Limitations and Future Research

A main limitation of this project could be that only alpha power was examined. Previous studies have not only examined alpha, but also additional waves such as beta, theta, delta and gamma waves in the brain (Bhattacharya & Petsche (2002; Cheung et al., 2014; Jung-Beeman et al., 2004; Konston et al., 2015). These additional waves could not be examined in the present project because of time constraints. The more extensive dataset was considered to provide too much data for one person to process within a year, therefore a clear and achievable goal was set just to examine alpha power. These additional brain waves may provide additional insight into what is happening in the brain during aesthetic appraisals, as they have been related to different processes. Furthermore, previous studies have also examined heart rate, heart rate variability and galvanic skin response, which are variables that may provide addional insights regarding the impact of artwork stimuli on physiological responses.

As indicated previously, the measure of flow used in this study only examined three characteristics (i.e., flow, concentration, and time distortion). Therefore, it is acknowledged that the type of flow experienced in this study may differ from Csikszentmihályi's (1975, 2000) flow theory. This is because participants were non-artists performing in an active goal-oriented task that involved appraising paintings. Cikszentmihályi (1998) proposed that activities that require a lower level of skill and challenge and that are less intensive and complex may produce microflow. It might be that HCHF categories of images were much lower in terms of skill and challenge balance than participants perceived. Therefore, participants in this study may have been experiencing states of microflow. Additionally, it could be that the total number of images viewed within the task and the time provided to view the images was not sufficient to produce flow states. These limitations occurred due to time constraints as EEG recordings are a lengthy process.

Suggestions for future research include examining facial expressions using electromyography to measure the initial and reflective impressions of images of different complexity and fluency levels (De Manzano et al., 2010; Droit-Volet, & Meck, 2007; Effron, Niedenthall, Gil, & Droit-Volet, 2006; Gerger, & Leder, 2015). Measuring electromyography activity would supplement self-report data of arousal and pleasantness. Furthermore, research has examined aesthetic appraisals by including eye tracking (Massaro, Savazzi, Di Dio, Freedberg, Gallese, Gilli, & Marchetti, 2012). This may be useful in future research to examine gazing behaviours and patterns when looking at and making aesthetic appraisals of different types of art.

Applied Implications

The original contribution of this work involves combining aspects of flow theory, aesthetic appraisals and EEG which have not been examined in combination before. This can apply to flow theory, as it shows that microflow might happen at relatively short periods of time in response to highly complex and challenging stimuli. It can explain within the PIA Model that HCHF images are more interesting and recruit greater neural networks across the whole brain. These findings may inform the neuro marketing and design industry professionals regarding which types of designs will attract the most interest from potential customers. Additionally, the findings may inform creators and artists in the development of their own art, perhaps suggesting that they should strive to develop images of highly fluent and highly complex artworks. The display of engaging art in public spaces such as schools might lead to improvement in affective states.

Conclusions

In summary, Experiment 1 revealed that the higher the complexity and conceptual fluency of the image, the higher the subjective self-reports of flow, concentration, time distortion, activation, pleasantness, aesthetic liking, conceptual fluency and complexity. This suggests that the more complex and conceptually fluent the image was, the more participants experienced increased flow states. Different patterns of alpha power were observed for different categories of images, specifically in the temporal lobe (T3, T5 and T6). This pattern of neural activity is related to inhibition of the attentional networks of the brain and quietening of internal dialogue in the brain.

Experiment 2 reinforced the findings of Experiment 1 as the higher the complexity and conceptual fluency of the image, the higher the subjective reports of flow, concentration, time distortion, activation, pleasantness, aesthetic liking, conceptual fluency and complexity. The EEG data revealed different types of patterns related to different categories of complexity and conceptual fluency. Increased alpha power was found particularly in the occipital lobes (i.e., O1 and O2) during the HCHF condition. This suggests that the brain may be recruiting more resources when viewing images of high complexity and conceptual fluency. Perhaps the increase of alpha power was associated with inhibition of the attentional networks and visual processing in the occipital lobe to limit visual distractions. Additionally, increased alpha in the LCLF condition was found in the temporal lobe (T3). This increase of alpha power in the LCLF condition may suggest increased self-talk in the brain to try and figure out the meaning of the image. Importantly, in both experiments a significant relationship between subjective self-reports of flow and alpha power was not observed.

Together, these findings suggest that when individuals gaze at images of varying complexities and conceptual fluency levels, they recruit more resources to be able to process and adapt accordingly. These adaptations involve either suppressing their attentional networks or increasing internal monologues. Different patterns of EEG data reveal different types of processing, which is dependent on the complexity and conceptual fluency of the image itself. Importantly, examining additional frequencies, such as beta, delta, gamma and theta may provide important information in identifying brain processes and require further investigation in future research.

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Appendices

Appendix A: Pilot Study – Qualtrics Questionnaires

19

How complex is this image to you?

Not at all complex — Very complex
0 10 20 30 40 50 60 70 80 90 100

Please click and drag the slider to rate the image complexity

→

16

How meaningful is this image to you?

Not at all meaningful — Very meaningful
0 10 20 30 40 50 60 70 80 90 100

Please click and drag the slider to rate the meaningfulness of this image

→

Appendix B: Pilot Study – Prolific Academic Demographic Information – Complexity Questionnaire

Descriptive Statistics

	N	Range	Minimum	Maximum	Sum	Mean	Std. Deviation	Variance
Age	101	45.00	.00	45.00	2756.00	27.2871	7.90486	62.487
Sex	101	1.00	.00	1.00	53.00	.5248	.50188	.252
Valid N (listwise)	101							

Appendix B: Pilot Study – Prolific Academic Demographic Information – Conceptual Fluency Questionnaire

Descriptive Statistics

	N	Range	Minimum	Maximum	Sum	Mean	Std. Deviation	Variance
Age	99	27.00	18.00	45.00	2777.00	28.0505	7.42634	55.150
Sex	99	2.00	.00	2.00	50.00	.5051	.52243	.273
Valid N (listwise)	99							

Appendix C: Pilot Study – Qualtrics Briefing Form

School of Psychology
Darwin Building
University of Central Lancashire
Preston
Lancashire
PR1 2HE

Qualtrics Briefing: Psychophysiological Markers of Flow-Feeling in Artistic Appreciation

Dear participant,

My name is Tammy Husselman and I am a post graduate MSc (by Research) Psychology student conducting my thesis under the supervision of Dr. Edson Filho within the School of Psychology. My project is entitled *Psychophysiological Markers of Flow-Feeling in Artistic Appreciation.* The main purpose of this research project is to examine aesthetic appraisals of street art murals.

As a participant in this study, you are given the freedom to withdraw without a reason, at any time up until the completion of the questionnaire. You can withdraw your answers by simply exiting the window and they will not be submitted. Your data will be destroyed upon withdrawal. Please note that your data will be completely anonymous and it will not be possible to withdraw from the experiment once you have clicked the next button and the questionnaire has ended.

If full consent to participate is provided, it is important to note that the data collected during the session may be published. However, participants' information will remain confidential through data anonymisation. Data will only be used solely for the purposes of this experiment. If additional data is required, then further consent will need to be sought. Once the data has been collected and the results have been statistically analysed, they will be made available to you upon request. All questionnaires will be stored in a locked filing cabinet and virtual data will be password protected. All the data from this study will remain strictly confidential to the extent required by law.
If consent to take part is confirmed, you will be asked to appraise photos of street art murals. Your self-reports of conceptual fluency and complexity will be recorded. There will be blocks of questions addressing each component of the aesthetic appraisals. Once the questionnaire ends, a debriefing will be provided with contact details of further support where required.

If you have any further questions regarding participation, please contact Tammy Husselman thusselman1@uclan.ac.uk, my project supervisor Dr. Edson Filho efilho@uclan.ac.uk or my co-supervisor Dr. Linden Ball lball@uclan.ac.uk. If you would like to talk to somebody outside of the research team, please contact the university officer for ethics ethicsinfo@uclan.ac.uk.

Thank you very much for your time.

Appendix D: Pilot Study – Qualtrics Consent Form

School of Psychology
Darwin Building
University of Central Lancashire
Preston
Lancashire
PR1 2HE

Qualtrics Consent Form: Psychophysiological Markers of Flow-Feeling in Artistic Appreciation

All responses are anonymous and this information will be used solely for the purposes of this research project. Before the experiment starts, you will be provided with instructions regarding the completion of the task. A requirement to participate in this research is that you need to be between 18 and 45 years of age and you must be able to read English fluently.

Please note that your data can be withdrawn at any time throughout the questionnaire by exiting the browser window. If you choose to withdraw by closing the browser window, your answers will not be recorded. However, once the questionnaire has been submitted by clicking the next button at the end, it cannot be withdrawn due to data anonymisation.

Please click on the box to indicate that you have fully read the briefing sheet and provide your consent to take part in this questionnaire.

Appendix E: Pilot Study – Qualtrics Debrief Form

School of Psychology
Darwin Building
University of Central Lancashire
Preston
Lancashire
PR1 2HE

Qualtrics Debriefing: Psychophysiological Markers of Flow-Feeling in Artistic Appreciation

Thank you very much for participating in this study examining the *Psychophysiological Markers of Flow-Feeling in Artistic Appreciation.* The project was a pilot study examining measures of conceptual fluency and complexity during aesthetic appraisals of street art. If there are any questions or concerns regarding this experiment, then please do not hesitate to contact the research team and we will be happy to address them.

We hope you enjoyed participating in this questionnaire. If you have any concerns, questions or wish to discuss anything regarding this research project, then please do not hesitate to contact a member of the research team. If any emotional concerns were experienced throughout the experiment, please email the UCLAN Counselling Service wellbeing@uclan.ac.uk. Alternatively if you wish to speak to somebody outside from the university counseling service, please email the Samaritans jo@samaritans.org or call them on 116 123 for a completely confidential conversation. As mentioned previously, you have the right to withdraw your data until you submit your answers at the end of the questionnaire, and should you wish to do so, then all of your data will be destroyed.

Statistical analysis will be conducted on all the data collected, to identify key areas associated with aesthetic appraisals and examine how brain activity and physiological states change according to image complexity. The results of this study may be published in an academic journal. However, the data will maintain confidentiality through anonymisation of the data. All data will be combined and averaged to create a topographical map for each brain wave type. If you would like to receive a write up of the results of this study, it can be requested by a member of the research team.

If you wish to raise any concerns about the research with people who are independent of the research team, please contact the university officer for ethics. You can contact them at officerforethics@uclan.ac.uk.

Thank you again for taking part. If you have any questions, please feel free to email Tammy Husselman thusselman1@uclan.ac.uk, my project supervisor Dr. Edson Filho efilho@uclan.ac.uk or my co-supervisor Dr. Linden Ball lball@uclan.ac.uk.

Appendix F: Pilot Study – Qualtrics Demographic Questions


Please select your age below

Under 18
18 - 24
25 - 34
35 - 44
45 - 54
55 - 64
65 - 74
75 - 84
85 or older

→

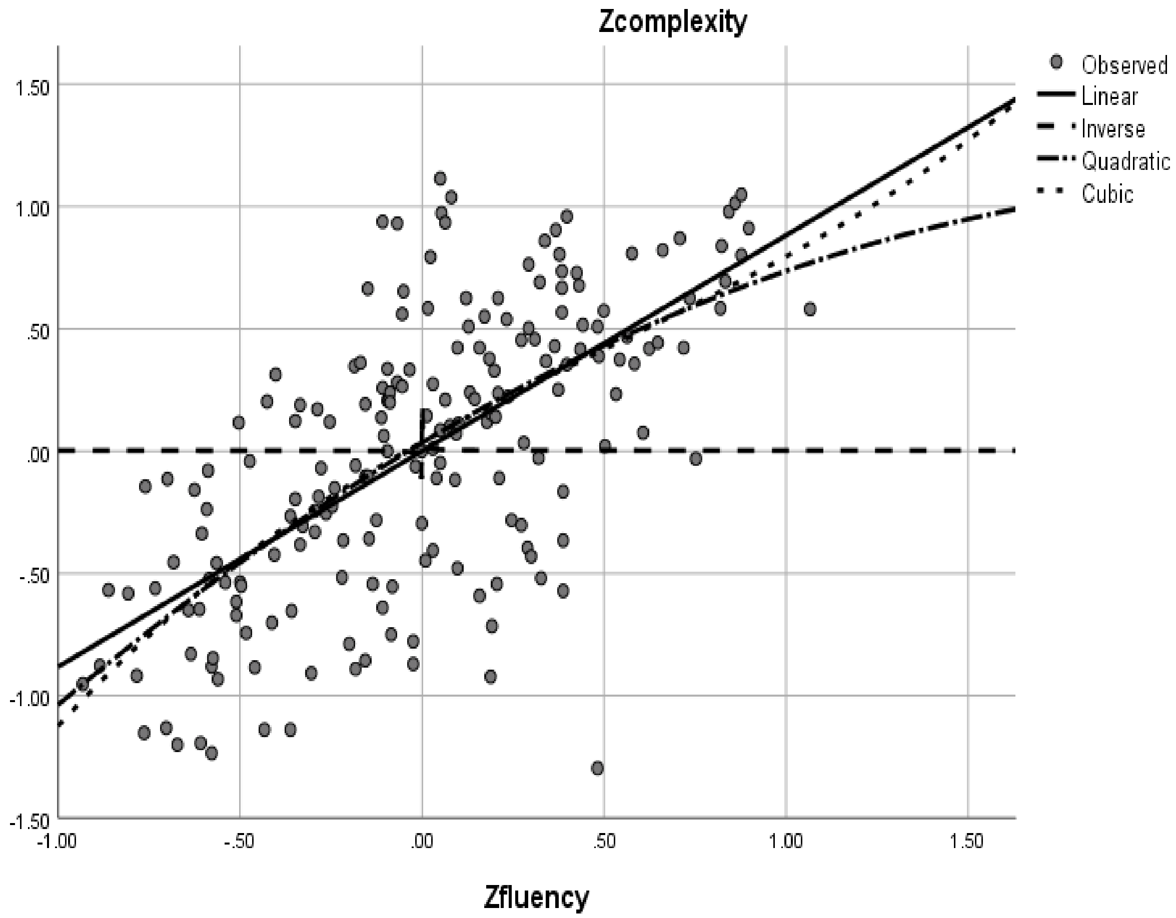

Please select your sex below

Male

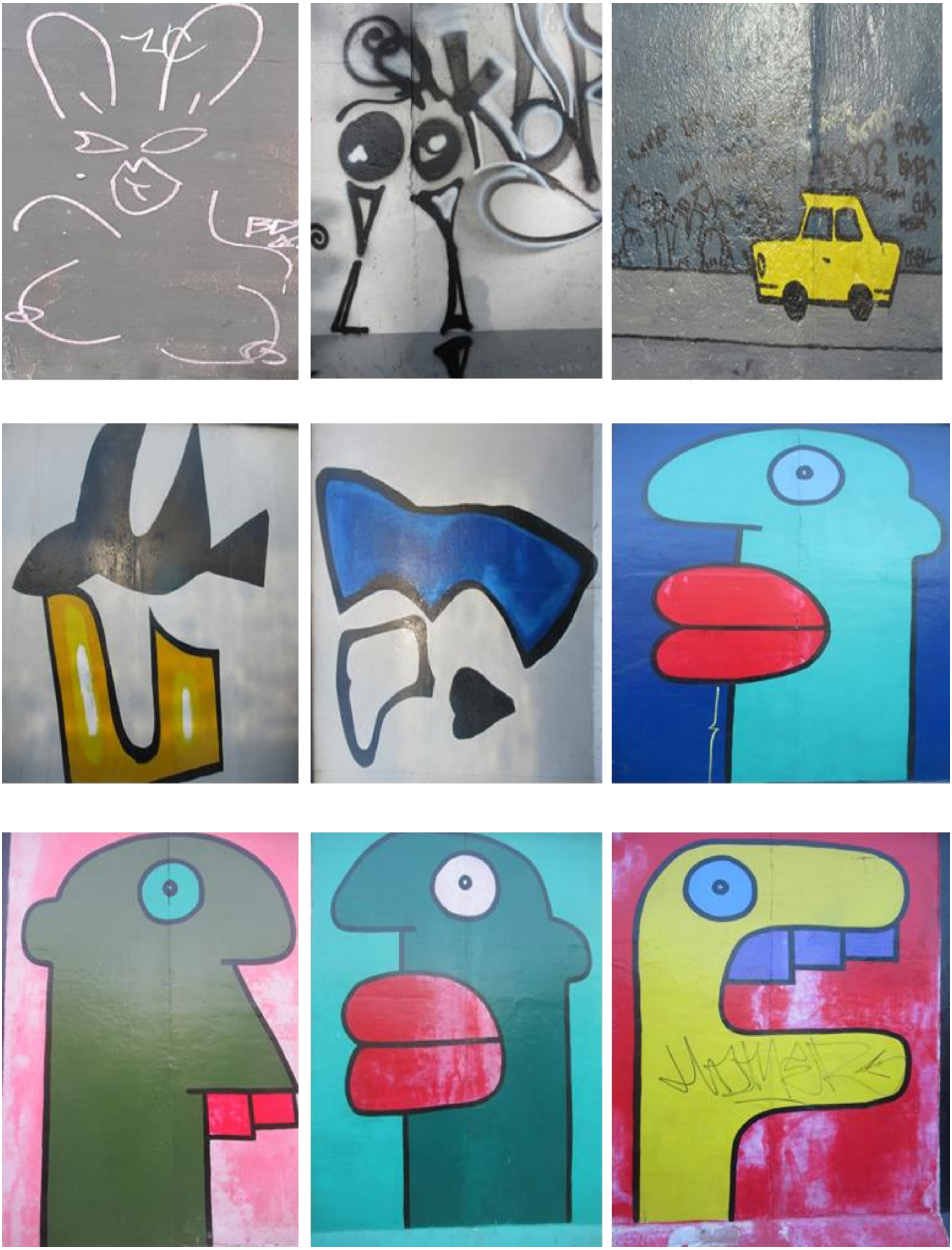
Female

→

Appendix G: Pilot Study: Exploratory Curve-Fit Estimations



Appendix H: Final 9 LCLF Categorised Images



Appendix H: Final 9 MCMF Categorised Images

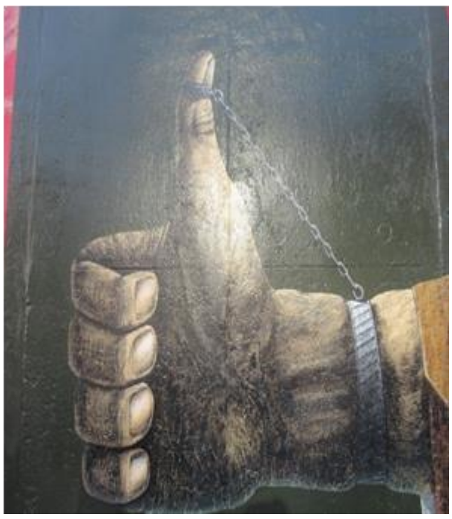
Appendix H: Final 9 HCHF Categorised Images











Appendix I: Ethical Approval Documents

uclan
University of Central Lancashire

UNIVERSITY OF CENTRAL LANCASHIRE Ethics Application Form

PLEASE NOTE THAT ONLY ELECTRONIC SUBMISSION IS ACCEPTED

This application form is to be used to seek approval from one of the three University Ethics Review Panels (BAHSS; PSYSOC & STEMH). Where this document refers to 'Ethics Review Panel' this denotes BAHSS; PSYSOC & STEMH. These Ethics Review Panels deal with all staff and postgraduate research student project. Taught (undergraduate and MSc dissertation projects) will normally be dealt with via School/Faculty process / committee.

If you are unsure whether your activity requires ethical approval please complete a UCLan Ethics Checklist. If the proposed activity involves animals, you should not use this form. Please contact the Ethics and Integrity Unit within Research Services – EthicsInfo@uclan.ac.uk – for further details.

Please refer to the notes for guidance on completion of the form.

If this application relates to project/phase which has previously been approved by one of the UCLan Ethics Review Panels, please supply the corresponding reference number(s) from your decision letter(s). ONLY REQUIRED FOR PHASED PROJECT SUBMISSIONS	
Previous Ethics Approval Ref No	

1.1 **Project Type:**

☐Staff Research ☐Commercial Project	☒Masters by Research ☐MPhil Research ☐PhD Research ☐Professional Doctorate	☐Taught MSc/MA Research ☐Undergrad Research ☐Internship

1.2 **Principal Investigator:**

Name	School	Email
Dr. Edson Filho	Psychology	efilho@uclan.ac.uk

1.3 **Other/Co- Researchers / Student:**

Name	School	Email
Dr. Linden Ball	Psychology	lball@uclan.ac.uk
Tammy-Ann Husselman	Psychology	thusselman1@uclan.ac.uk
	Choose an item.	

1.4 **Project Title:**

Psychophysiological Markers of Flow-Feeling in Artistic Appreciation

1.5 **Proposed Start Date:**

01/02/2019

1.6 **Proposed End Date:**

31/10/2019

1.7 **Is this project in receipt of any external funding** (including donations of samples, equipment etc.)?

☐Yes ☒No

If Yes, please provide details of sources of the funding and what part it plays in the current proposal.

1.8 **Project Description** (in layman's terms) including the aim(s) and justification of the project (max 300 words)

Give a brief summary of the background, purpose and the possible benefits of the project. This should include a statement on the academic rationale, context of the activity and justification for conducting the project.

Background & Overarching Purpose: Previous research has suggested that aesthetic experiences and flow states may be inherently connected (Csikzentmihályi & Robinson, 1990). Specifically, the *fluency* of an image (i.e., the ease of processing an image) may affect aesthetic liking and trigger flow-feeling experiences (Belke, Leder, Strobach, & Carbon, 2010; Graf & Landwehr, 2015). In turn, when in "flow", people experience changes in psychophysiological states, report a distorted sense of time, and a state of total concentration (Csikszentmihályi, 1975, 2000). In this context, the purpose of this project is to examine psychophysiological changes that characterize flow-feeling during aesthetic appreciation. In particular, the purpose is to examine psychophysiological markers of flow-feeling experiences related to aesthetic appraisals of street art, measured through EEG brain activity (e.g., alpha, beta and theta waves), physiological markers (e.g., galvanic skin response (GSR), heart rate (HR), facial electromyography (fEMG), and subjective reports. Noteworthy, two studies have been proposed to examine the psychophysiological markers of flow-feeling experiences in relation to aesthetic appreciation of street art of varying complexity levels (i.e., low, moderate and high); the studies will also examine the effects of time on aesthetic appraisals.

Study 1: Study 1 will consist of a repeated measures design. Study 1 aims to examine whether artworks of moderate complexity (optimal challenge-skill balance and fluency) are more likely to induce flow-feeling states, particularly psychophysiological markers of automaticity and time distortion, than artworks perceived as either low or high in complexity.

Study 2: In Study 2 participants will have a constrained time window, informed by the results of Study 1, to gaze at artworks of low, moderate and high complexity. The purpose is to examine whether, given the same viewing time, artworks of moderate complexity will induce more intense concentration, a key marker of flow-feeling, than artworks of low or high complexity.

References

Belke, B., Leder, H., Strobach, T., & Carbon, C.C. (2010). Cognitive fluency: High-level processing dynamics in art appreciation. *Psychology of Aesthetics, Creativity, and the Arts*, *4*(4), 214-222. doi: 10.1037/a0019648.

Csikszentmihályi, M. (2000). *Beyond boredom and anxiety*. San Francisco: Jossey-Bass Publishers. (Original work published 1975).

Csikszentmihályi, M., & Robinson, R.E. (1990). *The art of seeing: An interpretation of the aesthetic encounter*. Los Angeles, California: Getty Center for Education in the Arts.

Graf, L.K., & Landwehr, J.R. (2015). A dual-process perspective on fluency-based aesthetics. *Personality and Social Psychology Review*, *19*(4), 395-410. doi/10.1177/1088868315574978.

1.9 **Methodology** Please be specific

Provide an outline of the proposed method, include details of sample numbers, source of samples, type of data collected, equipment required and any modifications thereof, etc.

Participants

A minimum of 300 participants will be recruited for a pilot study aimed at identifying images of low, moderate, and high complexity. This number is akin to general guidelines on the development of reliable abstract measures (see measurement theory in Allen & Yen, 2001 *Introduction to measurement theory*. Waveland Press). Furthermore, 32 participants will be recruited (16 for Study 1) and (16 for Study 2). The approximate sample size for these studies was calculated through an a priori power analysis (effect size = .60, power = .80, alpha level = .05), which was informed by previous research on the neural markers of peak performance experiences (Bertollo et al., 2016). The sample of participants will consist of the general population, including UCLan staff and students, aged between 18-45 years.

Pilot Study

Participants will be asked to rate a set of 195 photos/images (https://msuclanac-my.sharepoint.com/:u:/g/personal/thusselman1_uclan_ac_uk/EbMw9cgc8k9PgSZ413aPp7IBQ1-XiicEfHwwyCnytCUr5A?e=l3ov0Z) in terms of *complexity* and *conceptual fluency* (see Appendix A). Participants' scores will be descriptively analyzed to create a total of thirty photos/images (i.e., 10 low complexity, 10 moderate complexity and 10 high complexity) that will be used in Studies 1 and 2. A Specific briefing form (Appendix B), informed consent (Appendix C) and debrief form(Appendix D) will be used for this group of participants, who will also be asked to respond to demographic questions (Appendix E). This study will take place online using the qualtrics platform (https://uclan.eu.qualtrics.com/jfe/form/SV_aaPkdNtvL9djWex) and the prolific academic website (https://prolific.ac/). A preview example of the qualtrics questionnaire is shown in Appendix E.

Experimental Task (Studies 1 and 2)

A total of thirty photos/images of public street art murals (i.e., 10 low, 10 moderate and 10 high complexity) will be displayed, followed by a self-directed viewing time without a time limit (Study 1) or an imposed viewing time (Study 2). Each image will be followed by a white blank projector screen (i.e., inter-trial interval) displayed for 7 sec, akin to previous research in video based stimuli tasks (see Van Rooijen, Ploeger, & Kret, 2017).

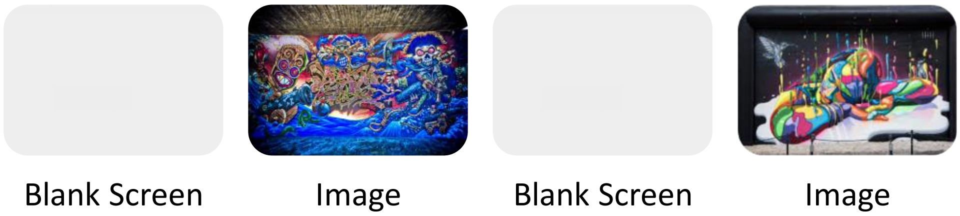


Figure 1. Schematic Representation of the Experimental Task

Procedures

A verbal briefing, information sheet and consent form will be provided before the experiment commences (see Appendix F and G).. EEG brain activity (i.e., alpha peak and theta/beta ratio) and peripheral physiological activity (i.e., heart rate, galvanic skin response and facial electromyography) will be recorded using the NeXus-32 Biofeedback System (see Figure 2). A two-minute eyes-closed baseline will be recorded. Another two-minute baseline will be recorded while participants' eyes remain open, viewing a blank white projector screen. In total, 30 (10 low, 10 moderate and 10 high complexity) abstract and representational images of street art will be presented in a randomized order to the participants. As In study 1, participants will have no time limit to gaze at each image (i.e., self-directed viewing time). In Study 2 participants will have a constrained time window, informed by the results of Study 1. Participant will report their affective states (i.e., arousal and pleasantness) at baseline, and before and after each trial. After each image has been presented, subjective measures of complexity, meaningfulness, aesthetic liking, the affect grid and the flow-feeling short scale questionnaires (see Appendix A) will be administered. Participants will also be asked to provide a retrospective report regarding their thoughts and emotions experienced during their viewing of the street art murals. Participants will be given the opportunity to ask questions and raise concerns, in which the verbal and written debriefing (see Appendix J) will follow when the experiment has been completed.

Measures

Objective Measures

The NeXus-32 BioFeedback System will be used record both central and peripheral physiological activity. In particular, alpha peak, theta/beta ratio (TBR), facial electromyography (fEMG), heart rate (HR) and galvanic skin response (GSR) will be continuously monitored throughout the experiment.

Subjective Measures (see Appendix A)

Participants in both Study 1 and 2 will provide subjective measures of their psychological states through single-item measures given that flow-feeling experiences have been related to subjective appraisals (Fritz & Avsec, 2007). Participants will provide self-reports of conceptual fluency, stimulus complexity, affective states, perceptions of flow, aesthetic liking and a retrospective think-aloud protocol.

Figure 2. An Example of The Nexus-32 System

References

Van Rooijen. R., Ploeger, A., & Kret. M.E. (2017) The dot-probe task to measure emotional attention: A susuitable measure in comparative studies? *Psychonomic Bulletin & Review, 24*(6), 1686-1717.

Fritz, B.S., Avsec, A. (2007) The experience of flow and subjective well-being of music students. *Horizons of Psychology*, *16*(2), 1318-187.

1.10 **Has the quality of the project been assessed**? (select all that apply)

☐Independent external review

☐Internal review (e.g. involving colleagues, academic supervisor, School process)

☒Research Programme Approval gained on Click here to enter a date. ***(Please that RPA is a prerequisite for Research Degree Student, including Prof Doc, projects to be able to submit for ethics)***

☐None

☐Other

If other please give details

1.11 **Please provide details as to the storage and protection of your physical / electronic data for the next 5 years** – as per UCLan requirements – **or whichever archive period is appropriate**
Physical copies of data from the experiment will be kept in a locked filing cabinet in the office of the principal investigator. Safeguards will be implemented to protect the participants' identity through anonymising the electronic data and ensuring electronic files are password protected. The physical and electronic data will be stored for the next five years in accordance to General Data Protection Regulations.
1.12 **How is it intended the results of the study will be reported and disseminated**? (select all that apply)
☒Peer reviewed journal – hard copy or online ☐Internal report ☒Conference presentation ☐Other publication ☐Written feedback to research participants ☒Presentation to participants or relevant community groups ☒Dissertation/Thesis ☐Other
If other, please give details
1.13 **Will the activity involve any external organisation for which separate and specific approval is required** (e.g. NHS; school; any criminal justice agencies including the Police, Crown Prosecution Service, Prison Service or Probation Service)?
☐Yes ☒No *IF **YES**, BEFORE PROCEEDING WITH THIS FORM, click here to CHECK WHEN, HOW AND WHAT IS REQUIRED*
If Yes, please provided details of the external organisation and attached letter of approval
1.14 **The nature of this project is most appropriately described as research involving:-** (more than one may apply)

☐Behavioural observation
☒Questionnaire(s) – *please provide a copy of the questionnaire / survey*
☐Interview(s) – *please provide a list of questions to be asked, or if semi-structured the topics*
☐Qualitative methodologies (e.g. focus groups) –*please provide the questions/topics to be covered*
☒Psychological experiments
☐Epidemiological studies
☐Data linkage studies
☐Psychiatric or clinical psychology studies
☐Human physiological investigation(s)
☐Biomechanical device(s)
☐Human tissue(s)*
☐Human genetic analysis
☐A clinical trial of drug(s) or device(s)
☒Lab-based experiment – *please provide relevant COHSS / RA forms*
☐Archaeological excavation/fieldwork
☐Re-analysis of archaeological finds/ancient artefacts
☐Human remains analysis
☐Lone working or travel to unfamiliar places (e.g. interviews in participants homes) – *please provide relevant risk assessment form*
☐Other (please specify in the box below)

If 'Other' please provide details

1.15 **Human Participants, Date or Material – the project will involve:**

Please select the appropriate box(es)

☒Participants [proceed to next question 1.16]
☐Data [proceed to question 1.30]
☐Tissues /Fluids / DNA Samples [proceed to question 1.31]
☐Remains [proceed to question 1.32]

1.16 **Will the participants be from any of the following groups:**
(tick as many as applicable)

☒Students or staff of this University[†]
☐Children/legal minors (anyone under the age of 18 years)
☐Patients or clients of professionals
☐Those with learning disability
☐Those who are unconscious, severely ill, or have a terminal illness
☐Those in emergency situations
☐Those with mental illness (particular if detained under Mental Health Legislation)
☐People with dementia
☐Prisoners
☐Young Offenders
☐Adults who are unable to consent for themselves
☐Any other person whose capacity to consent may be compromised
☐A member of an organisation where another individual may also need to give consent
☐Those who could be considered to have a particularly dependent relationship with the investigator, e.g. those in care homes
☐Other vulnerable groups (please list in box below)

[†] Please email EthicsInfo@uclan.ac.uk if any project involves HT

[†] Where staff or students of the university are being used please explain how this is not a convenience sampling

If 'Other' please provide details
1.16a **Justify their inclusion**
*Ethics approval covers **all participants** but particular attention must be given to those in a vulnerable category. Therefore you need to fully justify their inclusion and give details of extra steps taken to assure their protection.*
The participant sample will consist of an opportunity sample of the general population and may also include students and staff at the University of Central Lancashire aged between 18-45. Participants will not have any history of neurological disorders.
1.16b **Is a DBS – Disclosure and Barring Service (formerly CRB – Criminal Records Bureau) check required?**
Certain activities and/or groups of individuals require DBS (formerly CRB) clearance. If unclear please seek advice.
☐Yes ☒No
If Yes, please advise status of DBS clearance (e.g. gained; in process; etc)
1.16c **All staff should be aware of UCLan's Policy and Procedures on Safeguarding and Prevent. Please confirm that, where relevant to your project, the appropriate training has been undertaken.**
Please refer to UCLan Safeguarding Children, Young people and Vulnerable Adults Policy and Prevent guidance
☒Yes ☐No ☐N/A
If Yes, please give details of relevant training session – external or internal - and when (e.g. within last 3 years)
The student researcher has completed this training during her Undergraduate Summer Internship – June 2018. The project supervisors have completed the training.
1.17 **Please indicate exactly how participants in the study will be (i) identified, (ii) approached and (iii) recruited**?

If an advertisement and/or information sheet is being used, please attach
Flyers advertising the study will be displayed on the UCLAN campus within the School of Psychology on designated notice boards only. Online advertisement will also take place through the SONA system. Data collection will be scheduled according to the availability of the participants.
1.18 W**ill consent be sought from the participants and how will this be obtained**?
If a written consent form is being used, please attach
All participants will be asked to sign a written consent form which will explain the aims, purpose and methodology of the study.
1.19 **How long will the participants have to decide whether to take part in the research**?
There will be no specific time that participants will need to decide. They will be able to decide and schedule according to their availability and specify a date and a time to take part in data collection.
1.20 **What arrangements have been made for participants who might not adequately understand verbal explanations or written information, or who have special communication needs**?
Gives details of what arrangements have been made (e.g. translation, use of interpreters, etc).
All participants will be required to be fluent in English because there are elements of data collection which requires verbal and written feedback (e.g., retrospective reports and self-report questionnaires and) in English.
1.21**Payment or incentives: Do you propose to pay or reward participants**?
☒Yes ☐No
If Yes, please provided details
SONA points or £10 Amazon vouchers will be used to compensate participants for their time (1 SONA point per 15 minutes of participation time). As the experiment lasts for approximately 2 hours, £5 will be awarded per hour.
1.22 **Will deception of the participant be necessary during the activity**?
☐Yes ☒No
If Yes, please provide justification, and complete Question 1.28
1.23 **Does your project involve the potential imbalance of power/authority/status, particularly those which might compromise a participant giving informed consent**?
☒Yes ☐No
If Yes, please detail including how this will mitigated *Describe the relationship and the steps to be taken by the investigator to ensure that participation is purely voluntary and not influenced by the relationship in any way.*

Some individuals, particularly staff and students at UCLAN, may feel pressure to take part in the study. To minimize the feelings of obligation, participants will be reminded by the researcher that participation is completely voluntary and be informed that they may withdraw at any time during testing.
1.24 **Does the procedure involve <u>any</u> possible distress, discomfort or harm (or offense) to participants or researchers** (including physical, social, emotional, psychological and/or aims to shock / offed – e.g. Art)?
☒Yes ☐No
If Yes, please explain *Describe the potential for distress, discomfort, harm or offense and what measures are in place to protect the participants or researcher(s). Please consider all possible causes of distress carefully, including likely reaction to the subject matter, debriefing or participant upset.*
Participants may be offended by the subliminal messages conveyed by the murals or by their own interpretation of the piece of art. Furthermore, participants may experience discomfort wearing the EEG cap alongside the bio-feedback sensors for galvanic skin response, heart rate and fEMG. The researcher will reassure that these methods to collect data have been consistently used in previous psychological research and that they are safe to use. Participants may experience discomfort when asked to complete self-report questionnaires on their emotional states and retrospective reports. When data collection is complete, participants will be provided with a debriefing and further contact details for emotional support and well-being services if it is required.
1.25 **Does the activity involve any information pertaining to illegal activities or materials or the disclosure thereof**?
☐Yes ☒No
If Yes, please detail *Describe involvement and explain what risk management procedures will be put in place.*
1.26 **What mechanism is there for participants to withdraw from the investigation and how is this communicated to the participants**?
Participants will be informed during the briefing before data collection that they can withdraw any time until they end of the experiment. However, when they leave the laboratory they will not be able to withdraw their data due to data anonymization.
1.27 **What are the potential benefits for the research**?
There are no immediate benefits to the participants. Generally, this research may advance knowledge on the link between brain activity and physiological markers related to flow-feeling and aesthetic appraisals of street art (murals).
1.28 **Debriefing, Support and/or Feedback to participants**
Describe any debriefing, support or feedback that participants will received following the project and when.

Participants will be provided with a debriefing, in which the purposes and methodologies of the study will be explained. They will be informed about the relationship between flow states and aesthetic appraisals and what this study expects to find. Participants will be provided with a chance to ask questions and raise concerns, which will then be addressed by the researcher.

1.29 **Will the project involve access to confidential information about people without their consent**?

☐Yes ☒No

If yes, please explain and justify

State what information will be sought, from which organisations and the requirement for this information.

1.30 **Confidentiality/Anonymity** - Will the activity involve:	Yes	No
a. non-anonymisation of participants (i.e. researchers may or will know the identity of participants and be able to return responses)?	☐	☒
b. participants having the consented option of being identified in any publication arising from the research?	☐	☒
c. the use of personal data (i.e. anything that may identify them – e.g. institutional role – see DP checklist for further guidance)?	☒	☐

*If **yes to any** please attach completed Data Protection (DP) checklist*

1.31 **Does the activity involve human tissue?**[‡] See **Human Tissue Act (HTA) Supplementary list of Materials** to check what is classified as human tissue.

☐Yes ☒No

If no, please skip to question 1.32

If yes, please detail and answer questions 1.31a-c

1.31a **Who will be sourcing the human tissue? (e.g. a tissue bank governed by its own HTA licence)**

1.31b **Will the human tissue be stored at UCLan? (please note restrictions on storage)**

☐Yes ☒No

If yes, please state how long and in what form - cellular or acellular (DNA extracted)

Please note – if human tissue is only kept for the purpose of DNA extraction rendering it acellular the HTA storage regulations may not apply. If holding for DNA extraction, please state the length of time the tissue would be stored pre-extraction.

1.31c **Is the human tissue being used for an activity listed as a 'scheduled purpose' under Schedule 1 Parts 1 and 2 of the Human Tissue Act 2004?** *(click here to see list of HTA 'scheduled purpose' activities)*

☐Yes ☒No

1.32 **Does the project involve excavation and study of human remains**?
☐Yes ☒No
If yes, please give details *Discuss the provisions for examination of the remains and the management of any community/public concerns, legal requirement etc.*

‡ Until such time as the University gains its own HTA Research License, human tissue that is for a 'scheduled purpose' and not sourced from a BioBank or part of an NREC approved project can only be stored for a maximum of 5 days

DECLARATION

This declaration needs to be signed by the Principal Investigator (PI), and the student where it relates to a student project (for research student projects PI is Director of Studies and for Taught or Undergrad project the PI is the Supervisor). Electronic submission of the form is required to EthicsInfo@uclan.ac.uk. Where available insert electronic signature – alternatively, provide an email in lieu from appropriate party.

Declaration of the:
Principal Investigator
OR
Director of Studies/Supervisor and Student Investigator
(please check as appropriate)
• The information in this form is accurate to the best of my knowledge and belief, and I take full responsibility for it.
• I have read and understand the University Ethical Principles for Teaching, Research, Knowledge Transfer, Consultancy and Related Activities.
• I have read and understand the University's policy and procedures on Safeguarding and Prevent.
• I undertake to abide by the ethical principles underlying the Declaration of Helsinki and the University Code of Conduct for Research, together with the codes of practice laid down by any relevant professional or learned society.
• If the activity is approved, I undertake to adhere to the study plan, the terms of the full application of which the Ethics Review Panel* has given a favourable opinion and any conditions of the Ethics Review Panel in giving its favourable opinion.
• I undertake to seek an ethical opinion from the Ethics Review Panel before implementing substantial amendments to the study plan or to the terms of the full application of which the Ethics Review Panel has given a favourable opinion.

•	I understand that I am responsible for monitoring the research at all times.
•	If there are any serious adverse events, I understand that I am responsible for immediately stopping the research and alerting the Ethics Review Panel within 24 hours of the occurrence, via EthicsInfo@uclan.ac.uk.
•	I am aware of my responsibility to be up to date and comply with the requirements of the law and relevant guidelines relating to security and confidentiality of personal data.
•	I understand that research records/data may be subject to inspection for audit purposes if required in future.
•	I understand that personal data about me as a researcher in this application is required by the Ethics and Integrity Unit within Research Services, on behalf of the University, for the purpose of ethics review, and to evidence that the appropriate level of ethics review has been undertaken. Such data will be stored and managed in accordance with the principles established in the General Data Protection Regulations (GDPR) and the Data Protection Act 2018.
•	I understand that the information contained in this application, any supporting documentation and all correspondence with the Ethics Review relating to the application, will be subject to the provisions of the Freedom of Information Acts. The information may be disclosed in response to requests made under the Acts except where statutory exemptions apply.
•	I understand that all conditions apply to any co-applicants and researchers involved in the study, and that it is my responsibility to ensure that they abide by them.

* Ethics Review Panel refers to BAHSS, PSYSOC or STEMH

• **For Principal Investigator:** I understand my responsibilities to work within a set of ethical and other guidelines as set out by the University Policies and/or professional standards.	
• **For Supervisor/Director of Studies:** I understand my responsibilities as Supervisor/Director of Studies, and will ensure, to the best of my abilities, that the student investigator abides by the University's Policy on Research Ethics at all times.	
• **For the Student Investigator**: I understand my responsibilities to work within a set of ethical and other guidelines as agreed in advance with my Supervisor/Director of Studies and understand that I must comply with the University's regulations and any other applicable code of ethics at all times.	
☐**Signature of Principal Investigator:** **or** ☒**Supervisor or Director of Studies**	
Print Name:	
Date:	Click here to enter a date.
Signature of Student Investigator:	
Print Name:	Tammy-Ann Husselman
Date:	31/12/2018

Appendix A

Single-Item Measures Questionnaire

Please provide a rating on how you felt overall during the appraisal of the street art photo as honestly as possible. Thank you.

Please circle the rate of **conceptual fluency:** present in the image (How meaningful is this picture to you?):

0 **Not at all Meaningful**	10	20	30	40	50	60	70	80	9

Please circle the rate of **complexity:** present in the image (How complex is this picture to you?):

0 Not at all Complex	1		3	4	50	6	7	8	9	**100 Very Complex**

Please circle the rate of your perceived **arousal level:** (How much did you enjoy the task?)

1 Sleepiness	2	3	4	**5 N**	6	7	8	9	**10 High Arousal**

Please circle the rate of your perceived **levels concentration:** (I was completely focused on the task at hand):

0 Not at all	1	2	3	4	5	6	7	8	9	**10 Very Much**

Please circle the rate of your perceived **time distortion:** (The way time passed seemed different from normal):

0 Not at all	1	2	3	4	5	6	7	8	9	**10 Very Much**

Please circle the rate your **aesthetic liking:** (How much did you like the image?):

0 Not at all	1	2	3	4	5	6	7	8	9	**10 Very Much**

Thank you very much for taking the time to complete this questionnaire.

Appendix B

School of Psychology

Darwin Building

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Preston

Lancashire

PR1 2HE

Qualtrics Briefing: Psychophysiological Markers of Flow-Feeling in Artistic Appreciation

Dear participant,

My name is Tammy Husselman and I am a post graduate MSc (by Research) Psychology student conducting my thesis under the supervision of Dr. Edson Filho within the School of Psychology. My project is entitled *Psychophysiological Markers of Flow-Feeling in Artistic Appreciation.* The main purpose of this research project is to examine aesthetic appraisals of street art murals.

As a participant in this study, you are given the freedom to withdraw without a reason, at any time up until the completion of the questionnaire. You can withdraw your answers by simply exiting the window and the answers will not be submitted. Your data will be destroyed upon withdrawal. Please note that your data will be completely anonymous and it will not be possible to withdraw from the experiment once you have clicked the next button and the questionnaire has ended.

If full consent to participate is provided, it is important to note that the data collected during the session may be published. However, participants' information will remain confidential through data anonymisation. Data will only be used solely for the purposes of this experiment. Once the data has been collected and the results have been statistically analysed, they will be made available to you upon request. All data will be stored in password protected computers. All the data from this study will remain strictly confidential to the extent required by law.

If consent to take part is confirmed, you will be asked to appraise photos of street art murals. Your self-reports of conceptual fluency and complexity will be recorded. There will be blocks of questions addressing each component of the aesthetic appraisals. Once the questionnaire ends, a debriefing will be provided with contact details of further support where required.

If you have any further questions regarding participation, please contact Tammy Husselman thusselman1@uclan.ac.uk, my project supervisor Dr. Edson Filho, efilho@uclan.ac.uk or my co-supervisor Dr. Linden Ball, lball@uclan.ac.uk. If you would like to talk to somebody outside of the research team, please contact the university officer for ethics, ethicsinfo@uclan.ac.uk.

Thank you very much for your time.

Appendix B

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Qualtrics Consent Form: Psychophysiological Markers of Flow-Feeling in Artistic Appreciation

All responses are anonymous and this information will be used solely for the purposes of this research project. Before the experiment starts, you will be provided with instructions regarding the completion of the task. A requirement to participate in this research is that you need to be between 18 and 45 years of age and you must be able to read English fluently.

Please note that your data can be withdrawn at any time throughout the questionnaire by exiting the browser window. If you choose to withdraw by closing the browser window, your answers will not be recorded. However, once the questionnaire has been submitted by clicking the next button at the end, it cannot be withdrawn due to data anonymisation.

Please click on the box to indicate that you have fully read the briefing sheet and provide your consent to take part in this questionnaire.

Appendix E

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PR1 2HE

Qualtrics Debriefing: Psychophysiological Markers of Flow-Feeling in Artistic Appreciation

Thank you for participating in this study examining the *Psychophysiological Markers of Flow-Feeling in Artistic Appreciation.* The purpose of this study was to examine your perceptions of conceptual fluency and complexity during aesthetic appraisals of street art.

As mentioned previously, you have the right to withdraw your data until you submit your answers at the end of the questionnaire, and should you wish to do so, then all of your data will be destroyed.

Statistical analysis will be conducted on all the data collected, to identify key areas associated with aesthetic appraisals. The results of this study may be published in an academic journal. However, the data will maintain confidentiality through anonymisation of the data. If you would like to receive a write up of the results of this study, please email a member of the research team.

We hope you enjoyed participating in this study. If you have any concerns, questions or wish to discuss anything regarding this research project, then please do not hesitate to contact a member of the research team. If any emotional distress was experienced throughout the experiment, please email the Samaritans jo@samaritans.org or call them on 116 123 for a completely confidential conversation. If you are a student at UCLAN, please consider emailing the Counselling Service at wellbeing@uclan.ac.uk.

If you wish to raise any concerns about the research with people who are independent of the research team, please contact the university officer for ethics. You can contact them at officerforethics@uclan.ac.uk.

Thank you again for taking part. If you have any questions, please feel free to email Tammy Husselman, thusselman1@uclan.ac.uk, my project supervisor Dr. Edson Filho, efilho@uclan.ac.uk or my co-supervisor Dr. Linden Ball, lball@uclan.ac.uk.

Appendix E

Preview Question

Please select your age below

Under 18
18 - 24
25 - 34
35 - 44
45 - 54
55 - 64
65 - 74
75 - 84
85 or older

Preview Question

Please select your sex below

Male

Female

Image Preview

16

How complex is this image to you?

Not at all complex									Very complex	
0	10	20	30	40	50	60	70	80	90	100

Please click and drag the slider to rate the image complexity

18

How meaningful is this image to you?

Not at all meaningful									Very meaningful	
0	10	20	30	40	50	60	70	80	90	100

Please click and drag the slider to rate the meaningfulness of this image

Appendix F

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PR1 2HE

Briefing: Psychophysiological Markers of Flow-Feeling in Artistic Appreciation

Dear participant,

My name is Tammy Husselman and I am a post graduate MSc (by Research) Psychology student conducting my thesis under the supervision of Dr. Edson Filho within the School of Psychology. My project is entitled *Psychophysiological Markers of Flow-Feeling in Artistic Appreciation.* The main purpose of this research project is to examine the psychophysiological and brain activity related to aesthetic appraisals of street art murals.

As a participant in this study, you are given the freedom to withdraw from the experiment without a reason, at any time until you leave the laboratory. Please notify the researcher present if you would like to withdraw from the study at any point during testing. Your data will be destroyed upon withdrawal. Please note that your data will be completely anonymised and it will not be possible to be withdrawn from the experiment once testing has ended.

If consent to take part is confirmed, the experiment will last for approximately 2 hours. The first hour will involve EEG cap and gel application. This will be followed by approximately 1 hour of data collection. During the experiment you will be asked to appraise photos of street art murals on a projector screen. Additionally, you will wear an EEG brain imagining cap, facial electromyography (fEMG) and biofeedback sensors. Your self-reports of conceptual fluency, complexity, affective states, flow states and aesthetic liking will be recorded after each viewing of the street art. Once the experiment ends, the researcher will provide a debriefing with the opportunity to answer your questions and provide further support where required.

All questionnaires will be stored in a locked filing cabinet and virtual data will be password protected. All the data from this study will remain strictly confidential to the extent required by law.

If full consent to participate is provided, it is important to note that the data collected during the session may be published. However, participants' information will remain confidential through data anonymisation. Data will only be used solely for the purposes of this experiment. If additional data is required, then further consent will need to be sought. Once the data has been collected and the results have been statistically analysed, they will be made available to you upon request.

If you have any further questions regarding participation, please contact Tammy Husselman thusselman1@uclan.ac.uk, my project supervisor Dr. Edson Filho efilho@uclan.ac.uk or my co-supervisor Dr. Linden Ball lball@uclan.ac.uk. If you would like to talk to somebody outside of the research team, please contact the university officer for ethics ethicsinfo@uclan.ac.uk.

Thank you very much for your time.

Appendix G

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Consent Form: Psychophysiological Markers of Flow-Feeling in Artistic Appreciation

Please read through the following statements below and initial the boxes that you feel have been discussed during the briefing of the experiment.

	Please initial box
The goals of this research project have been explained and I have been given the opportunity to ask questions.	☐
I am aware that I may withdraw at any time during testing, as my participation in this study is completely voluntary.	☐
I understand that my data can be withdrawn at any time during the experiment. However, upon leaving the testing location, I will no longer be able to withdraw my data due to anonymisation.	☐
I agree to allow recording of EEG and biofeedback sensors for the purpose of this study.	☐

I agree to respond to psychological surveys on my self-reported conceptual fluency, complexity, affective states, flow and aesthetic liking and provide retrospective verbal feedback on photos of paintings. ☐

☐

I provide my consent to take part in this study.

I have been asked to participate in an experiment that will examine an area of Psychology and I provide my consent by signing this form.

______________________	______________	______________________
Participant Number	Date	Signature
______________________	______________	______________________
Name of Researcher	Date	Signature

Appendix H

RISK ASSESSMENT FORM	
	uclan University of Central Lancashire

Risk Assessment For	Assessment Undertaken By	Assessment Reviewed By
Service / School / Faculty: Psychology	**Name:** **B Hornby, S Whittle, Lea Pilgrim, Edson Filho and other EEG users**	**Name:** **Edson Filho**
Location of Activity: Laboratory within the School of Psychology – Social Interaction and Performance Science (SINAPSE) Lab. Darwin Building 140	**Date:** **17/1/18**	**Date: 23/01/2019**
Activity: Data collection using the Nexus 32 Biofeedback Equipment. Data collection involving seated participants viewing photos of street art on a projector screen.	**Signed by Dean of Faculty / Head of School / Director of Service or their nominee:** Linden J. Ball **Date: 03/07/2018**	You should review your risk assessment if you think it might no longer be valid (e.g. following an accident in the workplace or if there are any significant changes to hazards, such as new work equipment or work activities)

What are the actual or potential hazards? (List in order of importance)	**List groups of people who might be harmed by the hazards and state how they may be harmed?**	**What are the existing controls in place?** (Operational, procedural, policy, instructions, training, competency, PPE, consultation, etc.)	**Do you need to do anything else to control this risk?**	**Action by who?**	**Action by when?**	**Status? Complete / outstanding**	**Remaining level of risk (low, medium or high)**
Tripping and falling over the cables.	Participants and experimenter	All cables will be tied neatly, away from where participants will be sitting. The furniture will be moved away from the same area to minimise the risk of accidents.	No	Researcher	Prior to data collection.	N/A	Low
Allergic reactions to the EEG electrode gel.	Participants who are allergic to plasters or have pre-existing dermatological conditions.	Participants will be asked about any known allergies or skin conditions. If these allergies and skin conditions are known, they will be asked not to take part in the study.	No	Researcher	Prior to data collection.	N/A	Low
Epileptic seizures	Participants	All participants will be asked about any medical history of epileptic seizures and screened prior to taking part in the study. Any participant with a history of neurological disorders will not be recruited as a participant.	No	Researcher	Prior to data collection.	N/A	Low

Unknown neurological disorders	Participants who have an unknown neurological disorder.	In case of an emergency where the participant experiences an epileptic seizure, faints, becomes unconscious or experiences symptoms of an unknown neurological disorder, the first aid officer would need to be called and informed of the situation. They would need to be made aware if the person is unresponsive/not breathing, so that a defibrillator can be brought with them. The first aid officers can be called from the telephone located in the health suite.	No	Researcher	During data collection.	N/A	Low
Electrocution hazard due to the Nexus being plugged into an electrical outlet.	Participants and experimenter	All the electrical equipment frequently used and plugged in to the lab is safety checked for faults or hazards every year.	No	Researcher	Prior to data collection.	N/A	Low
Mental fatigue/dizziness. As data collection is approximately two hours, participants may become fatigued which could lead to loss of concentration, dizziness and other issues such as feeling unwell.	Participants	Participants will be provided with frequent breaks at any time throughout the data collection period. Water will be offered throughout to reduce this risk.	No	Researcher and participants will communicate during the experiment as required.	Prior to and during data collection.	N/A	Low

Participants may assume that they will gain a clinically meaningful assessment.	Participants who may be unaware that the procedure will not involve a clinical diagnostic and those who may have existing health concerns.	Participants will receive a detailed explanation of the procedure and that anything recorded has no clinical validity. It will be explained that the research has been designed for quantitative research purposes only.	No	Researcher	Prior to data collection, the briefing and debriefing.	N/A	Low
Injury caused by incorrect disposal of syringes and syringe applicators/blunt needles after data collection has finished.	Participants, experimenter, cleaning staff and the wider university community.	All syringes and blunt needles will be disposed of safely through the clinical waste route. All sharps will be disposed of immediately after data collection in the sharps bin available at the SINAPSE Lab to ensure safe disposal.	No	Researcher	After data collection.	N/A	Low

Appendix I

Psychophysiological Markers of Flow-Feeling in Artistic Appreciation

Study Description

My name is Tammy Husselman and I am a post graduate MSc (by Research) Psychology student. As part of my thesis, I require participants to volunteer in my EEG experiment examining the *Psychophysiological Markers of Flow-Feeling in Artistic Appreciation.*

How to participate

- Email to book an appointment
- EEG cap fitting (1 hour)
- Street art appraisal task (1 hour)

Available from March 2019

Monday-Friday: Mornings: 09:00/10:00 or Afternoons: 13:30/14:30

Contact Information

thusselman1@uclan.ac.uk

Please tear off my contact information & email me!

UCLAN | Tammy Husselman
thusselman1@uclan.ac.uk

UCLAN | Tammy Husselman
thusselman1@uclan.ac.uk

UCLAN | Tammy Husselman
thusselman1@uclan.ac.uk

UCLAN | Tammy Husselman
thusselman1@uclan.ac.uk

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thusselman1@uclan.ac.uk

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thusselman1@uclan.ac.uk

UCLAN | Tammy Husselman
thusselman1@uclan.ac.uk

UCLAN | Tammy Husselman
thusselman1@uclan.ac.uk

Appendix J

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PR1 2HE

Debriefing: Psychophysiological Markers of Flow-Feeling in Artistic Appreciation

Thank you very much for participating in this study examining the *Psychophysiological Markers of Flow-Feeling in Artistic Appreciation.* This project was examining the changes in brain activity and psychophysiological states during aesthetic appraisals of street art. If there are any concerns or questions in regards to this experiment, then please do not hesitate to ask and we will be happy to address them.

We hope you enjoyed taking part in this experiment. Should you have any concerns, questions or wish to discuss anything in regards to this experiment then please do not hesitate to contact a member of the research team. If any emotional concerns were experienced throughout the experiment, please email the UCLAN Counselling Service wellbeing@uclan.ac.uk. Alternatively if you wish to speak to somebody outside from the university counseling service, please email the Samaritans jo@samaritans.org or call them on 116 123 for a completely confidential conversation. As mentioned previously, you have the right to withdraw your data until you leave this laboratory, and should you wish to do so all of your data will be destroyed.

Statistical analysis will be conducted on all the data collected, to identify key areas associated with aesthetic appraisals and examine how brain activity and physiological states change according to image complexity. The results of this study may be published in an academic journal. However, the data will maintain confidentiality through anonymisation of the data. All data will be combined and averaged to create a topographical map for each brain wave type. If you would like to receive a write up of the results of this study, it can be requested by a member of the research team.

If you wish to raise any concerns about the research with people who are independent of the research team, please contact the university officer for ethics. You can contact them at ethicsinfo@uclan.ac.uk.

Thank you again for taking part. If you have any questions, please feel free to email Tammy Husselman thusselman1@uclan.ac.uk, my project supervisor Dr. Edson Filho efilho@uclan.ac.uk or my co-supervisor Dr. Linden Ball lball@uclan.ac.uk.

Appendix J: Subjective Reports

Single-Item Measures Questionnaire

Please provide ratings of how you felt overall during the appraisal of the street art photo as honestly as possible. Thank you.

Please circle the rate of your perceived **flow state:** “I felt like I was in flow… I felt like I was “in the zone”. On a scale of 0 (not at all) to 10 (very much), how much do you agree with this in regards to the image?

0 (not at all)	1	2	3	4	5	6	7	8	9	**10 (very much)**

Please circle the rate of your perceived **level of concentration:** “I was completely focused on the image”. On a scale of 0 (not at all) to 10 (very much), how much do you agree with this in regards to the image?

0 (not at all)	1	2	3	4	5	6	7	8	9	**10 (very much)**

Please circle the rate of your perceived **time distortion:** “Time seemed to pass at a different pace while I was looking at the image”. On a scale of 0 (not at all) to 10 (very much), how much do you agree with this in regards to the image?

0 (not at all)	1	2	3	4	5	6	7	8	9	**10 (very much)**

Please circle the rate of your perceived **activation level:** On a scale of 0 (total sleepiness) to 10 (highly activated) how activated did you feel while looking at the image?

0(total sleepiness)	2	3	4	**5 (neither low/high)**	6	7	8	**10 (highly activated)**

Please circle the rate of your perceived **level of affect:** On a scale of 0 (not at all pleasant) to 10 (highly pleasant) how pleasant/enjoyable was it to look at the image?

0 (not at all pleasant)	2	3	4	**5 (neither low/high)**	6	7	8	**10 (highly pleasant)**

Please provide ratings about the street art photo as honestly as possible. Thank you.

Please circle the rate your **aesthetic liking:** On a scale of 0 (not at all) to 10 (very much), how much did you like the image?

0 (not at all)	1	2	3	4	5	6	7	8	9	**10 (very much)**

Please circle the rate of **conceptual fluency:** How meaningful was the image to you on a scale of 0 (not meaningful at all) to 100 (very meaningful)?

0 (not meaningful at all)	10	20	30	40	50	60	70	80	90	**100 (very meaningful)**

Please circle the rate of **complexity:** How complex was the image to you on a scale of 0 (not complex at all) to 100 (very complex)?

0 (not complex at all)	10	20	30	40	50	60	70	80	90	**100 (very complex)**

Thank you very much for taking the time to complete this questionnaire.

Appendix K: Counter-Balancing – Experiment 1

Block_ID	Original_Block_Order	Participant_1	Participant_2	Participant_3
1	Low	3	2	1
2	Moderate	1	1	3
3	High	2	3	2
Image_ID	Original_Order_Image_Number	Participant_1	Participant_2	Participant_3
1	Final_LCLF 109.00	Final_HCHF 44.00	Final_MCMF 132.00	Final_LCLF 94.00
2	Final_LCLF 27.00	Final_HCHF 48.00	Final_MCMF 121.00	Final_LCLF 133.00
3	Final_LCLF 134.00	Final_HCHF 106.00	Final_MCMF 4.00	Final_LCLF 135.00
4	Final_LCLF 136.00	Final_HCHF 49.00	Final_MCMF 187.00	Final_LCLF 136.00
5	Final_LCLF 108.00	Final_HCHF 46.00	Final_MCMF 56.00	Final_LCLF 109.00
6	Final_LCLF 135.00	Final_HCHF 52.00	Final_MCMF 67.00	Final_LCLF 27.00
7	Final_LCLF 133.00	Final_HCHF 29.00	Final_MCMF 168.00	Final_LCLF 105.00
8	Final_LCLF 94.00	Final_HCHF 45.00	Final_MCMF 181.00	Final_LCLF 108.00
9	Final_LCLF 105.00	Final_HCHF 55.00	Final_MCMF 172.00	Final_LCLF 134.00
10	Final_MCMF 56.00	Final_LCLF 133.00	Final_LCLF 136.00	Final_HCHF 106.00
11	Final_MCMF 172.00	Final_LCLF 135.00	Final_LCLF 108.00	Final_HCHF 49.00
12	Final_MCMF 168.00	Final_LCLF 109.00	Final_LCLF 27.00	Final_HCHF 55.00
13	Final_MCMF 132.00	Final_LCLF 108.00	Final_LCLF 135.00	Final_HCHF 45.00
14	Final_MCMF 121.00	Final_LCLF 134.00	Final_LCLF 134.00	Final_HCHF 44.00
15	Final_MCMF 181.00	Final_LCLF 94.00	Final_LCLF 133.00	Final_HCHF 29.00
16	Final_MCMF 67.00	Final_LCLF 105.00	Final_LCLF 109.00	Final_HCHF 52.00
17	Final_MCMF 187.00	Final_LCLF 27.00	Final_LCLF 105.00	Final_HCHF 46.00
18	Final_MCMF 4.00	Final_LCLF 136.00	Final_LCLF 94.00	Final_HCHF 48.00
19	Final_HCHF 29.00	Final_MCMF 67.00	Final_HCHF 55.00	Final_MCMF 121.00
20	Final_HCHF 46.00	Final_MCMF 172.00	Final_HCHF 52.00	Final_MCMF 67.00
21	Final_HCHF 45.00	Final_MCMF 121.00	Final_HCHF 106.00	Final_MCMF 132.00
22	Final_HCHF 55.00	Final_MCMF 132.00	Final_HCHF 29.00	Final_MCMF 4.00
23	Final_HCHF 106.00	Final_MCMF 187.00	Final_HCHF 49.00	Final_MCMF 181.00
24	Final_HCHF 48.00	Final_MCMF 181.00	Final_HCHF 46.00	Final_MCMF 56.00
25	Final_HCHF 44.00	Final_MCMF 56.00	Final_HCHF 48.00	Final_MCMF 168.00
26	Final_HCHF 49.00	Final_MCMF 168.00	Final_HCHF 44.00	Final_MCMF 172.00
27	Final_HCHF 52.00	Final_MCMF 4.00	Final_HCHF 45.00	Final_MCMF 187.00

Appendix K: Counter-Balancing – Experiment 2

Block_ID	Original_Block_Order	Participant_1	Participant_2	Participant_3
1	Low	3	2	1
2	Moderate	2	1	2
3	High	1	3	3
Image_ID	Original_Order_Image_Number	Participant_1	Participant_2	Participant_3
1	Final_LCLF 109.00	Final_HCHF 44.00	Final_MCMF 121.00	Final_LCLF 109.00
2	Final_LCLF 27.00	Final_HCHF 45.00	Final_MCMF 4.00	Final_LCLF 108.00
3	Final_LCLF 134.00	Final_HCHF 106.00	Final_MCMF 181.00	Final_LCLF 134.00
4	Final_LCLF 136.00	Final_HCHF 52.00	Final_MCMF 132.00	Final_LCLF 135.00
5	Final_LCLF 108.00	Final_HCHF 48.00	Final_MCMF 172.00	Final_LCLF 136.00
6	Final_LCLF 135.00	Final_HCHF 29.00	Final_MCMF 168.00	Final_LCLF 94.00
7	Final_LCLF 133.00	Final_HCHF 49.00	Final_MCMF 187.00	Final_LCLF 27.00
8	Final_LCLF 94.00	Final_HCHF 46.00	Final_MCMF 56.00	Final_LCLF 133.00
9	Final_LCLF 105.00	Final_HCHF 55.00	Final_MCMF 67.00	Final_LCLF 105.00
10	Final_MCMF 56.00	Final_MCMF 4.00	Final_LCLF 108.00	Final_MCMF 187.00
11	Final_MCMF 172.00	Final_MCMF 67.00	Final_LCLF 134.00	Final_MCMF 181.00
12	Final_MCMF 168.00	Final_MCMF 121.00	Final_LCLF 94.00	Final_MCMF 168.00
13	Final_MCMF 132.00	Final_MCMF 187.00	Final_LCLF 109.00	Final_MCMF 121.00
14	Final_MCMF 121.00	Final_MCMF 181.00	Final_LCLF 136.00	Final_MCMF 172.00
15	Final_MCMF 181.00	Final_MCMF 132.00	Final_LCLF 135.00	Final_MCMF 67.00
16	Final_MCMF 67.00	Final_MCMF 172.00	Final_LCLF 27.00	Final_MCMF 56.00
17	Final_MCMF 187.00	Final_MCMF 56.00	Final_LCLF 105.00	Final_MCMF 4.00
18	Final_MCMF 4.00	Final_MCMF 168.00	Final_LCLF 133.00	Final_MCMF 132.00
19	Final_HCHF 29.00	Final_LCLF 105.00	Final_HCHF 52.00	Final_HCHF 49.00
20	Final_HCHF 46.00	Final_LCLF 133.00	Final_HCHF 44.00	Final_HCHF 46.00
21	Final_HCHF 45.00	Final_LCLF 109.00	Final_HCHF 29.00	Final_HCHF 44.00
22	Final_HCHF 55.00	Final_LCLF 135.00	Final_HCHF 48.00	Final_HCHF 55.00
23	Final_HCHF 106.00	Final_LCLF 27.00	Final_HCHF 45.00	Final_HCHF 45.00
24	Final_HCHF 48.00	Final_LCLF 134.00	Final_HCHF 49.00	Final_HCHF 52.00
25	Final_HCHF 44.00	Final_LCLF 94.00	Final_HCHF 55.00	Final_HCHF 48.00
26	Final_HCHF 49.00	Final_LCLF 108.00	Final_HCHF 46.00	Final_HCHF 29.00
27	Final_HCHF 52.00	Final_LCLF 136.00	Final_HCHF 106.00	Final_HCHF 106.00

Appendix L: Briefing

School of Psychology
Darwin Building
University of Central Lancashire
Preston
Lancashire
PR1 2HE

Briefing: Psychophysiological Markers of Flow-Feeling in Artistic Appreciation

Dear participant,

My name is Tammy Husselman and I am a postgraduate MSc (by Research) Psychology student conducting my thesis under the supervision of Dr. Edson Filho within the School of Psychology. My project is entitled *Psychophysiological Markers of Flow-Feeling in Artistic Appreciation.* The main purpose of this research project is to examine the psychophysiological and brain activity related to aesthetic appraisals of street art murals.

As a participant in this study, you are given the freedom to withdraw from the experiment without a reason at any time until you leave the laboratory. Please notify the researcher present if you would like to withdraw from the study at any point during testing. Your data will be destroyed upon withdrawal. Please note that your data will be completely anonymised and it will not be possible to be withdrawn from the experiment once testing has ended.

If consent to take part is confirmed, the experiment will last for approximately 2 hours. The first hour will involve EEG cap and gel application. This will be followed by approximately 1 hour of data collection. During the experiment you will be asked to appraise photos of street art murals displayed on a television screen. Additionally, you will wear an EEG brain imagining cap and biofeedback sensors. Your self-reports of conceptual fluency, complexity, affective states, flow states and aesthetic liking will be recorded after each viewing of the street art. Once the experiment ends, the researcher will provide a debriefing with the opportunity to answer your questions and provide further support where required.

All questionnaires will be stored in a locked filing cabinet and virtual data will be password protected. All the data from this study will remain strictly confidential to the extent required by law.

If full consent to participate is provided, it is important to note that the data collected during the session may be published. However, participants' information will remain confidential through data anonymisation. Data will only be used solely for the purposes of this experiment. If additional data is required, then further consent will need to be sought. Once the data has been collected and the results have been statistically analysed, they will be made available to you upon request.

If you have any further questions regarding participation, please contact Tammy Husselman thusselman1@uclan.ac.uk, my project supervisor Dr. Edson Filho efilho@uclan.ac.uk or my co-supervisor Dr. Linden Ball lball@uclan.ac.uk. If you would like to talk to somebody outside of the research team, please contact the university officer for ethics officerforethics@uclan.ac.uk.

Thank you very much for your time.

Appendix M: Consent Form

School of Psychology
Darwin Building
University of Central Lancashire
Preston
Lancashire
PR1 2HE

Consent Form: Psychophysiological Markers of Flow-Feeling in Artistic Appreciation

Please read through the following statements below and initial the boxes that you feel have been discussed during the briefing of the experiment.

	Please initial box
The goals of this research project have been explained and I have been given the opportunity to ask questions.	☐
I am aware that I may withdraw at any time during testing, as my participation in this study is completely voluntary.	☐
I understand that my data can be withdrawn at any time during the experiment. However, upon leaving the testing location, I will no longer be able to withdraw my data due to anonymisation.	☐
I agree to allow recording of EEG and biofeedback sensors for the purpose of this study.	☐
I agree to respond to psychological surveys monitoring self-reports of conceptual fluency, complexity, affective states, flow and aesthetic liking on photos of street art.	☐
I provide my consent to take part in this study.	☐

I have been asked to participate in an experiment that will examine an area of Psychology and I provide my consent by signing this form.

______________________	______________	______________________
Participant Number	Date	Signature
______________________	______________	______________________
Name of Researcher	Date	Signature

Appendix N: Demographic Information – Experiment 1

Participant Demographic Information & Response Sheet								
Researcher	P #	DoB	Age	M/F	Nationality	Occupation	Education	Study
TH	1	31/05/1996	23	M	British	Student	Masters Student	1
TH	2	23/01/1996	23	M	German	Student	Undergraduate Student	1
TH	3	06/05/1999	20	F	British	Student	Undergraduate Student	1
TH	4	22/08/1997	21	M	British	Retail Assistant	College	1
TH	5	15/08/1997	21	M	German	Student	Undergraduate Student	1
TH	6	24/03/1997	22	F	British	Student	Masters Student	1
TH	7	29/03/2000	19	F	Hungarian	Student	Undergraduate Student	1
TH	8	26/09/1995	23	F	British	Graduate Teaching Assistant	PhD Student	1
TH	9	26/02/1989	30	M	British	Principal Consultant	Undergraduate Student	1
TH	10	18/10/1996	22	M	Napali	Student	Undergraduate Student	1
TH	11	10/03/1996	22	F	British	Sales Assistant	Masters Student	1
TH	12	23/05/1993	26	M	British	Signal and Telegraph Operative	College	1
TH	13	03/04/1999	20	F	British	Student	Undergraduate Student	1
TH	14	06/01/1992	27	M	Iranian	Student	Undergraduate Student	1
TH	15	04/12/1996	22	F	British	Student	Undergraduate Student	1
TH	16	27/02/1981	38	F	British	Support Worker	Undergraduate Student	1

Appendix N: Demographic Information – Experiment 2

Participant Demographic Information & Response Sheet								
Researcher	P #	DoB	Age	M/F	Nationality	Occupation	Education	Study
TH	1	13/06/1970	49	M	British	Railw ay Worker	Primary and Secondary School	2
TH	2	19/02/1990	29	F	Bulgarian	Student	Undergraduate	2
TH	3	21/09/1995	23	F	British	Charity Worker	College	2
TH	4	23/04/1988	31	F	British	Railw ay Worker	College	2
TH	5	12/06/1993	26	F	British	Planning Manager for Railw ay	Undergraduate	2
TH	6	25/11/1994	24	M	British	Shelf Stacker at Argos	Undergraduate	2
TH	7	23/06/1997	22	F	British	Student	Postgraduate (MSc or PhD?)	2
TH	8	07/01/1999	20	M	British	Student	Undergraduate	2
TH	9	28/07/1975	43	F	British	Student	Undergraduate	2
TH	10	04/12/1992	26	M	British	None	Undergraduate (HNC)	2
TH	11	25/12/1974	44	M	British	Railw ay Track Worker	High School	2
TH	12	23/10/1900	28	F	British	Student	PhD Student	2
TH	13	29/09/1998	20	M	British	Student	Undergraduate	2
TH	14	23/02/1997	22	F	German	Student	Undergraduate	2
TH	15	16/02/1988	31	M	British	S&T Worker	Undergraduate	2
TH	16	31/03/1996	23	M	British	Student	Postgraduate (MSc Clinical Psychology)	2
TH	17	21/10/1998	20	M	British	Student	Undergraduate	2

Appendix O: Experiment 1 - Protocol

TASK	CHECKED?
Briefing	
Consent form signed	
Cap and Gel	
Check Impedance (under 10,000)	
Check Sampling Rate (256Hz)	
Heart Rate	
Galvanic Skin Response	
Recording Started	
Baseline Trigger for Eyes Closed (2min)	
Baseline for Eyes Open (2min)	
Experiment Starts	

Image is shown for 8 seconds	
Blank screen is shown for 3 seconds before and after the image.	
Flow	"I felt like I was in flow… I felt like I was "in the zone". On a scale of 0 (not at all) to 10 (very much), how much do you agree with this in regards to the image?
Short Flow State Scale	"I was completely focused on the image". On a scale of 0 (not at all) to 10 (very much), how much do you agree with this in regards to the image? "Time seemed to pass at a different pace while I was looking at the image". On a scale of 0 (not at all) to 10 (very much), how much do you agree with this in regards to the image?
Activation (Arousal) Pleasantness (Affect)	On a scale of 0 (total sleepiness) to 10 (highly activated) how activated did you feel while looking at the image? On a scale of 0 (not at all pleasant) to 10 (highly pleasant) how pleasant/enjoyable was it to look at the image?
Aesthetic liking	On a scale of 0 (not at all) to 10 (very much), how much did you like the image?
Meaningfulness (Conceptual Fluency)	How meaningful was the image to you on a scale of 0 (not meaningful at all) to 100 (very meaningful)?
Complexity	How complex was the image to you on a scale of 0 (not complex at all) to 100 (very complex)?

Appendix P: Experiment 1 - Instructions

Baseline Eyes Closed – 2 minutes

Please keep your eyes closed for two minutes and keep your movements to a minimum.

Baseline Eyes Open – 2 minutes

Please keep your eyes open for two minutes and keep your movements to a minimum.

Baseline Questions

Please rate as honestly as possible on how you felt during the baseline for activation and pleasantness.

Experiment

First of all, a blank screen will be presented for 3 seconds and then an image will be presented for 8 seconds, followed by another 3 second blank screen. The presentation will involve 3 blocks containing 9 images each, which will present 27 images of street art in total.

In between each trial, I will ask you to provide self-reports of experienced flow states and activation and pleasantness.

I will also ask you to provide ratings of the image itself, for example, aesthetic liking, conceptual fluency (meaningfulness) and complexity in regards to the images.

Definitions of Key Terms

Complexity

Please keep in mind that complexity is your own personal opinion of how complex you think the image is; there is no right or wrong answer.

Conceptual fluency/meaningfulness

Please keep in mind that meaningfulness is your own personal opinion of how meaningful you think the image is; there is no right or wrong answer.

Flow

Flow is more commonly referred to as being "in the zone". It is described as a positive affective mental state characterised by complete concentration and task absorption in the present moment. Consequently, flow is a state of intense concentration accompanied by automaticity and immersion, resulting in suppression of any sense of self, time and bodily functions.

Appendix Q: Experiment 1 – Response Sheet

Trigger#	Description	Image Number	Flow	Total Concentration	Time Distortion	Activation	Pleasantness	Aesthetic Liking	Meaningfulness	Complexity	Time Check	Notes
1 and 2	B Eyes Closed	Baseline										
3 and 4	B Eyes Open	Baseline										
5 and 6	B1T1											
7 and 8	B1T2											
9 and 10	B1T3											
11 and 12	B1T4											
13 and 14	B1T5											
15 and 16	B1T6											
17 and 18	B1T7											
19 and 20	B1T8											
21 and 22	B1T9											
23 and 24	Start & End Break											
25 and 26	B2T1											
27 and 28	B2T2											
29 and 30	B2T3											
31 and 32	B2T4											
33 and 34	B2T5											
35 and 36	B2T6											
37 and 38	B2T7											
39 and 40	B2T8											
41 and 42	B2T9											
43 and 44	Start & End Break											
45 and 46	B3T1											
47 and 48	B3T2											
49 and 50	B3T3											
51 and 52	B3T4											
53 and 54	B3T5											
55 and 56	B3T6											
57 and 58	B3T7											
58 and 59	B3T8											
60 and 61	B3T9											

Appendix R: Debriefing Sheet

School of Psychology
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Lancashire
PR1 2HE

Debriefing: Psychophysiological Markers of Flow-Feeling in Artistic Appreciation

Thank you very much for participating in this study examining the *Psychophysiological Markers of Flow-Feeling in Artistic Appreciation.* This project was examining the changes in brain activity and psychophysiological states during aesthetic appraisals of street art. If there are any concerns or questions in regards to this experiment, then please do not hesitate to ask and we will be happy to address them.

We hope you enjoyed taking part in this experiment. Should you have any concerns, questions or wish to discuss anything in regards to this experiment then please do not hesitate to contact a member of the research team. If any emotional concerns were experienced throughout the experiment, please email the UCLAN Counselling Service wellbeing@uclan.ac.uk. Alternatively if you wish to speak to somebody outside from the university counseling service, please email the Samaritans jo@samaritans.org or call them on 116 123 for a completely confidential conversation. As mentioned previously, you have the right to withdraw your data until you leave this laboratory, and should you wish to do so all of your data will be destroyed.

Statistical analyses will be conducted on all the data collected, to identify key areas associated with aesthetic appraisals and examine how brain activity and physiological states change according to image complexity. The results of this study may be published in an academic journal. However, the data will maintain confidentiality through anonymisation of the data. All data will be combined and averaged to create a topographical map for each brain wave type. If you would like to receive a write up of the results of this study, it can be requested by a member of the research team.

If you wish to raise any concerns about the research with people who are independent of the research team, please contact the university officer for ethics. You can contact them at officerforethics@uclan.ac.uk.

Thank you again for taking part. If you have any questions, please feel free to email Tammy Husselman thusselman1@uclan.ac.uk, my project supervisor Dr. Edson Filho efilho@uclan.ac.uk or my co-supervisor Dr. Linden Ball lball@uclan.ac.uk.

Appendix S: Experiment 2 - Instructions

Baseline Eyes Closed – 2 minutes

Please keep your eyes closed for two minutes and keep your movements to a minimum.

Baseline Eyes Open – 2 minutes

Please keep your eyes open for two minutes and keep your movements to a minimum.

Baseline Questions

Please rate as honestly as possible on how you felt during the baseline for activation and pleasantness.

Experiment

First of all, a blank screen will be presented for 3 seconds and then an image will be presented for 16 seconds, followed by another 3 second blank screen. The presentation will involve 3 blocks containing 9 images each, which will present 27 images of street art in total.

In between the presentation of each image, I will ask you to provide self-reports of experienced flow states and activation and pleasantness. I will also ask you to provide ratings of each image itself, for example, aesthetic liking, conceptual fluency (meaningfulness) and complexity in regards to the image.

Two-Response Procedure

A two-response procedure will be used during the self-report ratings of the image itself. This means that for each image, you will be asked to provide two separate ratings for aesthetic-liking, for complexity and for meaningfulness. What I would like you to do is look at the image and think about your response very quickly in order to provide your initial impression after the image has been presented for 5 seconds. The second aesthetic-liking, complexity and meaningfulness ratings should be provided after an additional 10 seconds of viewing time and will be your final impression. I would like you to think carefully about the image and reflect before your final ratings. Your final ratings may differ from your initial ratings. All of your responses will be collected at the end of each 16 second image trial to minimise movement artefacts from the EEG recording.

Definitions of Key Terms

Complexity

Please keep in mind that complexity is your own personal opinion of how complex you think the image is; there is no right or wrong answer.

Conceptual fluency/meaningfulness

Please keep in mind that meaningfulness is your own personal opinion of how meaningful you think the image is; there is no right or wrong answer.

Flow

Flow is more commonly referred to as being "in the zone". It is described as a positive affective mental state characterised by complete concentration and task absorption in the present moment. Consequently, flow is a state of intense concentration accompanied by automaticity and immersion, resulting in suppression of any sense of self, time and bodily functions.

Appendix T: Experiment 2 - Protocol

TASK	CHECKED?
Briefing	
Consent form signed	
Cap and Gel	
Check Impedance (under 10,000)	
Check Sampling Rate (256Hz)	
Heart Rate	
Galvanic Skin Response	
Recording Started	
Baseline Trigger for Eyes Closed (2min)	
Baseline for Eyes Open (2min)	
Experiment Starts	

Image is shown for 16 seconds	
Blank screen is shown for 3 seconds before and after the image.	
Flow	"I felt like I was in flow… I felt like I was "in the zone". On a scale of 0 (not at all) to 10 (very much), how much do you agree with this in regards to the image?
Short Flow State Scale	"I was completely focused on the image". On a scale of 0 (not at all) to 10 (very much), how much do you agree with this in regards to the image? "Time seemed to pass at a different pace while I was looking at the image". On a scale of 0 (not at all) to 10 (very much), how much do you agree with this in regards to the image?
Activation (Arousal) Pleasantness (Affect)	On a scale of 0 (total sleepiness) to 10 (highly activated) how activated did you feel while looking at the image? On a scale of 0 (not at all pleasant) to 10 (highly pleasant) how pleasant/enjoyable was it to look at the image?
Aesthetic liking	On a scale of 0 (not at all) to 10 (very much), how much did you like the image?
Meaningfulness (Conceptual Fluency)	How meaningful was the image to you on a scale of 0 (not meaningful at all) to 100 (very meaningful)?
Complexity	How complex was the image to you on a scale of 0 (not complex at all) to 100 (very complex)?

Appendix U: Experiment 2 - Response Sheet

Trigger#	Description	Image Number	Flow	Total Concentration	Time Distortion	Activation	Pleasantness	Aesthetic Liking (Initial)	Aesthetic Liking (Reflective)	Meaningfulness (Initial)	Meaningfulness (Reflective)	Complexity (Initial)	Complexity (Reflective)	Time Check	Notes
1 and 2	B Eyes Closed	Baseline													
3 and 4	B Eyes Open	Baseline													
5 and 6	B1T1														
7 and 8	B1T2														
9 and 10	B1T3														
11 and 12	B1T4														
13 and 14	B1T5														
15 and 16	B1T6														
17 and 18	B1T7														
19 and 20	B1T8														
21 and 22	B1T9														
23 and 24	Start & End Break														
25 and 26	B2T1														
27 and 28	B2T2														
29 and 30	B2T3														
31 and 32	B2T4														
33 and 34	B2T5														
35 and 36	B2T6														
37 and 38	B2T7														
39 and 40	B2T8														
41 and 42	B2T9														
43 and 44	Start & End Break														
45 and 46	B3T1														
47 and 48	B3T2														
49 and 50	B3T3														
51 and 52	B3T4														
53 and 54	B3T5														
55 and 56	B3T6														
57 and 58	B3T7														
59 and 60	B3T8														
61 and 62	B3T9														