Master thesis on Brain and Cognition

Universitat Pompeu Fabra

From conflict to creativity – exploring the cognitive processing of surrealist advertising imagery

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“To be a surrealist means barring from your mind all remembrance of what you have seen, and being always on the lookout for what has never been. ”

- René Magritte

Abstract

What happens when we view something that is incongruent with reality? This study explored whether surrealist advertising imagery, which uses incongruity as a creative device, results in similar physiological effects as the cognitive conflict in typical laboratory paradigms. It is well-known that tasks such as the Stroop task, the Simon task or the Flanker task are associated with an increase in the Theta band (4-8 Hz) activity at frontal locations, which has been interpreted as a neural correlate of cognitive conflict. In this study, participants viewed images selected from advertising, through an app-like display in order to recreate a real-life context. They were given a foil task, consisting of judging whether the image targeted men or women, while electroencephalography (EEG) was recorded. Images met one of three conditions: incongruent (surrealist advertising imagery in which some aspect of the image was incongruent with reality), congruent (controls for the latter in terms of content and physical attributes) and filler images (to discourage expectation and increase realism in the task). One week after the EEG experiment, participants were recalled to the lab and given a recognition memory test, where the images in the experiment were mixed with previously unseen, equivalent images. The EEG results showed that incongruent images elicited greater Theta activity in the frontal-medial electrodes when compared with congruent images. The delayed memory test showed that participants remembered the incongruent images better than the congruent ones. This result has several implications. First, it suggests that cognitive conflict may be important for the effective processing of creative communications – possibly explaining why some images stick in our memory and why others do not. Second, it extrapolates current cognitive conflict theories developed using idealized laboratory materials to real-life settings.

Introduction

In 1927, surrealist artist René Magritte began to place words in his paintings in order to provoke thought about the meaning of images and words. The painting 'La clef des songes' (1927) contains objects that are incongruent with the words written below them.

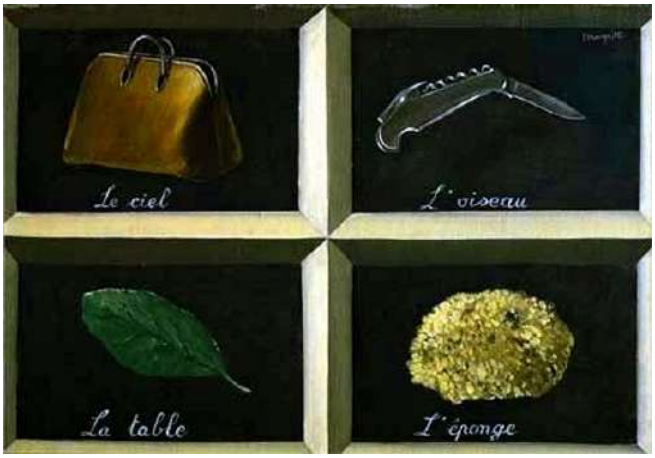


Figure 1 - Magritte, R. (1927). ***La clef des songes***

Eight years later, American psychologist John Ridley Stroop became interested in a similar phenomenon. In the experiment 'The Effect of Interfering Word Stimuli Upon Naming Colors Serially' (Stroop, 1935), he explored the behavorial difference between congruent name and color pairings (the word 'red' written in red ink) with incongruent name and color pairings (the word 'red' written in green ink). The delayed response times that incongruent name and color pairings elicit have since been linked to the neural correlates of cognitive conflict (Hanslmayr et al., 2008). The study that I present in this thesis aims to extend the body of research to real-world settings, focusing on surrealist advertising imagery.

Surrealistic art techniques, an outgrowth of the early 20th century artistic movement, deliberately try to defy reason. By exploitation of incongruous juxtapositions and un-orderly connections, surrealism stresses the subconscious or non-rational significance of imagery (Homer & Kahle, 1986). Today, surrealism extends to advertising, where incongruity is often used as a creative device. Advertisers involved in designing persuasive communications have long been interested in creative ways of capturing audience attention and the use of incongruity is one effective way to do so (Lee & Schumann, 2004). Furthermore, the ultimate aim of advertising is for the brand to be encoded and retained in memory so that it can be retrieved during a future purchase decision (Keller, 1987). Although it seems obvious that incongruous juxtapositions in advertising would create the desired effect (i.e. increased attention and memory), to date, there is no empirical evidence regarding the cognitive processing associated with incongruent imagery. Knowing more about the cognitive impact of common communication techniques (such as the use of surrealist images) can, on one hand, provide a key metric of advertising effectiveness (Keller, 1987). On the other hand, it can help extrapolate popular theories in cognitive conflict monitoring to real-life settings.

A popular theory in cognitive neuroscience is that cognitive control may be recruited, in part, when the anterior cingulate cortex (ACC) responds to conflict in information processing (Botvinick et al., 2001). The authors define cognitive conflict as "the simultaneous activation of incompatible representations". A reliable neural correlate of conflict is an increase in the power of oscillatory activity within the Theta band (4-8 Hz) over mid-frontal electrodes from EEG recordings (Cohen, 2014). Cohen & Ridderinkhof (2013) state that neural computations in the frontal medial (fm) cortex, where the ACC is, and its interactions with other cortical and subcortical areas, seem to be coordinated by oscillations in the Theta band (4-8 Hz), suggesting that ACC activation (measured with BOLD signal increase in fMRI) and fm-Theta (EEG) arise from the same mechanism. The conflict monitoring theory provides a good framework for testing the hypothesis implicitly formulated by advertising: does incongruity in surrealist advertising imagery generate cognitive conflict, as reflected in fm-Theta power (4-8Hz)? Specifically, the present study seeks to explore incongruity as a creative device in communications by measuring fm-Theta associated with incongruent imagery. We hypothesized that incongruent images generate more power at mid-frontal electrodes (Fz, Cz, Fcz) than control images that do not contain incongruity.

Please note that although conflict can occur at various stages of information processing (from perceptual representation, to stimulus categorisation and response selection) the majority of studies so far have focused on response selection conflict (Botvinick et al., 2004). According to the authors, the finding of ACC engagement in tasks requiring the overriding of pre-potent responses is one of the strongest established findings in cognitive neuroscience. This is supported by results showing increased power in Theta activity in classical conflict tasks such as the Stroop Task (Hanslmayr et al., 2008), the Flanker Task (Nigbur et al., 2011), as well as in the

Simon task (Cohen & Ridderinkhof, 2013); (Castro et al., 2018). Despite the body of literature focused on response conflict, to date, only a few studies have used conflict dissociation procedures to analyze both semantic and response conflict. Such techniques would allow for semantic conflict to be explored in isolation, furthering the knowledge base. For example, Weissman et al. (2003) set out to explore if the dACC also monitors for conflict at pre-response stages of information processing in a cued global/local attention task. A cue instructed participants to attend to and identify either the global ("G") or the local ("L") features of an upcoming stimulus and respond with their index finger if it was an H or S and middle finger if it was X or O. The task included several types of trials to determine the nature of conflict monitoring performed by the dACC: no conflict e.g. a global H made of local Hs (NC), pre-response conflict e.g. a global H made of local Ss (PC) and response conflict e.g. a global H made of local Xs (RC). Their reasoning was that if dACC monitors for conflict at pre-response as well as response stages, then both PC and RC trials should elicit greater dACC activity than NC trials. The results for the local task demonstrated that the dACC reached a higher peak value for PC trials than for NC trials, indicating pre-response conflict from global distracters was present. In the global task neither PC or RC trials activated the dACC significantly more than NC trials. However, RC trials activated the dACC significantly more than PC trials.

In a modified version of the Stroop Task that dissociated semantic and response conflict, Jiang, Zhang, & Van Gaal (2015) set out to explore how both sources of conflict are processed using EEG. Similarly to Weissman et al. (2003), there was three conditions: congruent condition (CO) where the word meaning is the same as the ink color and both have the same response button; the semantically incongruent condition (SI) where the word meaning and color are different, but have the same response button; and the response incongruent condition (RI) where the meaning and color are different and have different response buttons. The researchers observed that both semantic as well as response conflict were associated with mid-frontal theta-band. Based on these findings, we can assume that stimulus-response conflict as well as stimulus-stimulus conflict are both associated with ACC activation and Theta activity.

The aim of this study was to explore cognitive conflict in surrealist advertising imagery. However, considering that a key metric of advertising effectiveness is recall (e.g., how much do we remember of what was advertised), we decided to further explore the impact of conflict on memory. If conflict serves as an internal signal to activate cognitive control, it seems feasible that this additional recruitment of resources could also aid memory formation. Although the link between conflict and memory would appear to be a sensible assumption, research is not so abundant. In a review of visual memory capacity by Brady et al. (2012), they state that a number of studies have tested memory for objects in a scene as a function of semantic consistency, and the results show that items that are inconsistent with the scene are remembered better. For example, in a study by Friedman (1979) subjects generally noticed only the changes that had been made to the unexpected objects – memory for the presence of a coffeemaker was higher when the coffeemaker was shown in a farmyard compared to a kitchen.

In a paper by Krebs et al. (2015), the impact of cognitive conflict on memory has been recently explored. In a modified version of the Stroop Task, the face-word Stroop task where each face is overlaid with a congruent, incongruent or neutral gender, the authors found that incongruent distracters not only induced behavioral conflict by way of increased response times, but also gave rise to enhanced memory, supporting our assumption that neural conflict-control mechanisms can strengthen memory for target stimuli. Based on these findings, the second question our study wished to address was: does incongruity in imagery improve memorability? Our hypothesis was that incongruent images would be remembered better than control images that do not contain incongruity.

The study protocol, hypotheses and planned analyses were pre-registered at Open Science Framework (https://osf.io/wftd7/) on the 11th May 2018.

Materials & Methods

Participants

Data from 31 healthy participants (15 females) aged between 18-34 (22.22 ± 3.38), with normal or corrected-to-normal vision was recorded. Data from one participant was excluded because he/she failed to understand the instructions for the memory task. After EEG artifact rejection, data from participants (N=2) with less than 30 clean trials out of a total of 50 trials per condition were excluded. Data from one further participant were excluded because of a technical problem in EEG data storing. A total of 27 participants were left for the behavioral and EEG analyses. The experiment was run in accordance with the Declaration of Helsinki and approved by the ethics committee CEIC Parc de Mar (University Pompeu Fabra, Barcelona, Spain). Participants gave written informed consent before participating in the study and received a compensation of 10 euro/hour for their time.

Apparatus & stimuli

The experiment was designed and executed using Psychtoolbox (Brainard, 1997) on Matlab R2016b. Visual stimuli were presented through a CRT monitor (1024 x 768 pixels), with refresh rate of 60Hz and 32 bit color resolution. A set of 120 incongruent images were selected from image directories such as Pinterest (Pinterest, 2018) and Google Image Search (Google Images, 2018), with a variety of search queries: 'Creative Advertising', 'Smart Ads' 'Innovative Advertising' and 'Surrealist Ads'. One hundred and five of the selected images were advertisements and 15 were similar artistic images. The criterion for an image to be considered as incongruent was initially based on subjective evaluation of whether it could be considered 'out of the ordinary' in terms of the semantics or visual content of the image and if it contained two or more interacting objects that were usually unrelated, with a preference for realistic images that had been "photoshopped" (see Appendix 1 for an example).

A matching congruent image was selected for each of the 120 incongruent images as a control based on visual similarity, but lack of semantic incongruity. The tools used to find visually similar images were 'Google Reverse Image Search' (Google

Images, 2018), and the website 'Yandex' (Yandex Images, 2018). Reverse image search is a content-based image retrieval (CBIR) technique that involves providing the system with an image that it will then formulate its search upon. All images were edited in Photoshop to remove text and any branding (e.g., logos) if present.

All 240 images (120 incongruent images plus their controls) initially selected with the methods above were then subjected to a pre-test survey to determine levels of visual incongruity for each image objectively. We chose two questions for the survey, adapted from a study on the determinants of ad creativity by Smith et al. (2007). In Smith et al.'s study, the authors define creativity in advertising as divergence: the extent to which an ad contains elements that are different, novel, unusual or original. Creative ads are expected to attract more attention from consumers because their divergence contrasts with non-creative ads (Smith & Yang, 2004). Smith et al. (2007) developed and validated scales for measuring the key components of ad creativity over a series of six pre-tests involving 1,250 respondents. They defined seven main indicators of ad divergence:

- Flexibility: Ads that contain different switch from one perspective to another.
- Fluency: Ads that contain a large number of ideas—more than expected.
- Originality: Ads that contain elements that are rare, surprising, or move away from the obvious and commonplace.
- Elaboration: Ads that contain unexpected details, or finish and extend basic ideas so they become more intricate, complicated, or sophisticated.
- Synthesis: Ads that combine, connect, or blend normally unrelated objects.
- Artistic Value: Ads that contain artistic verbal impressions or attractive colors or shapes.

To measure incongruity in our images, we created a survey consisting of two statements per image, which respondents had to respond to using a scoring system from 1 (total disagreement) to 7 (total agreement). The two statements were related to the categories originality and synthesis from Smith et al.'s study (2007), deemed most relevant to determine image incongruity:

1. The image was out of the ordinary.
2. The image connected objects that are usually unrelated.

In order to shorten the duration of the task for volunteers participating in the survey, we divided the whole set of 240 images into three 80-image surveys randomly distributed online to acquaintances via the Qualtrics survey platform (Qualtrics, 2018). We obtained data from a total of 122 respondents, (N=48, 38 and 36, for Surveys 1, 2 and 3, respectively).

The results of the surveys were analyzed in order to discard images rated with low levels of incongruity from the experimental incongruent set, along with images rated with high levels of incongruity from the control set. Incongruent images with a mean rating of less than 4 were discarded and congruent images with a mean rating of 4 and above were discarded. The top 100 images in each condition were then selected (200 in total).

Fifty additional filler images were also selected by searching for trending topics on Twitter (Twitter, 2018) in various locations worldwide. A random mix of images related to current affairs, pop culture, sports and entertainment were chosen to mimic social media news feeds. These were included in the study to create a realistic social media context, to dilute the stark contrast between incongruent and congruent stimuli and to increase the overall number of images, making the subsequent memory task more difficult. A total of 250 images (100 incongruent + 100 controls + 50 fillers were used for the test).

For the test during the EEG recording, the one hundred incongruent images and their corresponding 100 congruent pairs were split into two equivalent sets (counterbalanced across participants) so that each image of the pair appears only once for each subject, and that all images appear the same number of times across the whole experiment. In addition to the 50 congruent and 50 incongruent images, each set also included the 50 fillers (not analyzed). Each participant viewed only one image set during the EEG recording and was tested using all images (from both sets) in the subsequent memory test.

EEG recording

EEG was continuously recorded through 16 active electrodes (Enobio, Neuroelectrics, Barcelona, Spain) with a custom electrode montage, focused around the mid-frontal area (see Appendix 4). Horizontal and vertical electro-oculograms (hEOG and vEOG) were recorded from two additional electrodes placed at the outer canthus and under the right eye, respectively. Other two additional electrodes were placed over the left and right mastoids for off-line re-referencing. Online reference electrodes CRM and DRL were clipped onto the left earlobe. The decision to use the Enobio headset was largely down to it being an agile (potentially wireless) EEG solution, easy to be implemented in non-academic contexts such as advertising, as our ambition was that this research could be applied to other fields.

EEG test phase

The experiment was performed in a dimly lit room and lasted about 1 hour. Each participant viewed 150 images (50 incongruent, 50 control and 50 filler) in random order and for each image, they were asked to decide whether they thought the image was directed to a male or female target viewer. This task had no significant relevance to the goals of the study and was devised merely to ensure participants looked at each image closely during the EEG recording phase. Participants rested their hands, palm down, with the index fingers positioned on the response keys of the computer keyboard (‘z’ and ‘m’ for left- and right-hand responses, respectively). The sequence of visual events was presented using a smartphone-like front screen presented in the center of the computer monitor. At the beginning of each trial, the smartphone displayed a wheel (mimicking a social media load screen) for 1500ms that served as fixation, followed by a randomly chosen incongruent, congruent or filler image. After 2000ms, a male and female icon appeared on either side of the image, signalling to participants that they could respond using the ‘z’ and ‘m’ keys, corresponding to a gender. The position of the male and female icons was randomised across trials so that participants could not prepare their response in advance. The next trial started after a randomly jittered 800 to 1000ms inter-trial interval following response. A total of 150 trials were presented in 5 experimental blocks of 30 trials each.

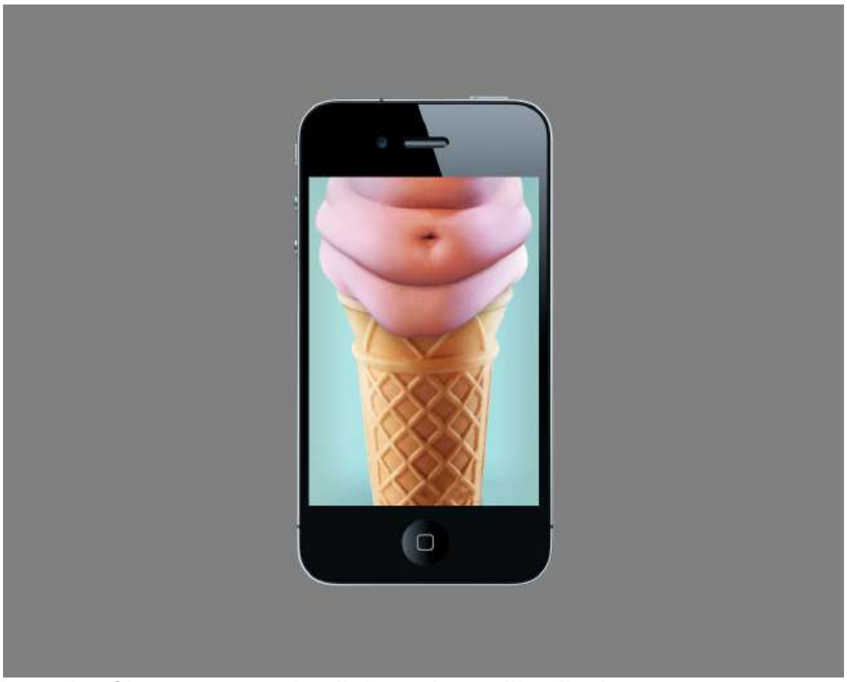


Figure 2 – Example of incongruent stimuli through app-like display

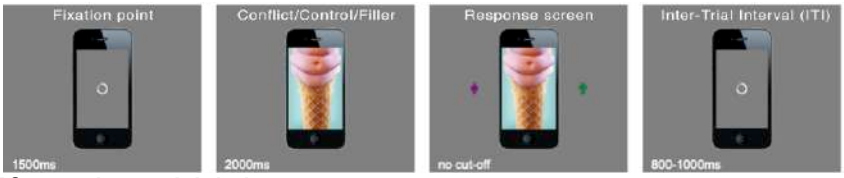


Figure 3 - EEG test phase trial timings

Memory test

Various pilot tests were performed prior to starting the experiment to determine the most appropriate memory test for this project. Our primary aim for the memory test was to address whether incongruent images were remembered better than congruent images. Our secondary aim was to ensure that participants had been looking at the images during the EEG test. The protocol chosen in the end involved inviting participants to come back to the lab one week after the EEG phase and to run a 2AFC (two-alternative forced choice) task regarding which of two images presented side-by-side they remembered seeing during the study session one week before. Participants were not informed about the memory test up until they finished the EEG phase. The memory test comprised of 200 images in total (the full set of images), including the 50 incongruent images previously seen paired with their 50 congruent pairs, which had not been seen. Similarly, they were presented with the 50 congruent images previously seen paired with their 50 incongruent pairs, which had not been seen. All images were transformed into black and white to encourage participants to rely on their conceptual memory of images, rather than some particular visual detail about color. Again, participants rested their hands, palm down, with the index fingers positioned on the response keys of the computer keyboard ('z' and 'm' for left- and right-hand responses, respectively). The image pairs appeared on screen for 1000ms and participants were instructed to respond as fast as possible, selecting the image they remembered seeing during the EEG test phase. Once the image disappeared, the fixation-cross remained until participants pressed either the 'z' or 'm' key, corresponding to the image on the left and the right-hand side. The next image appeared 1000ms after the response, with a total of 100 trials.

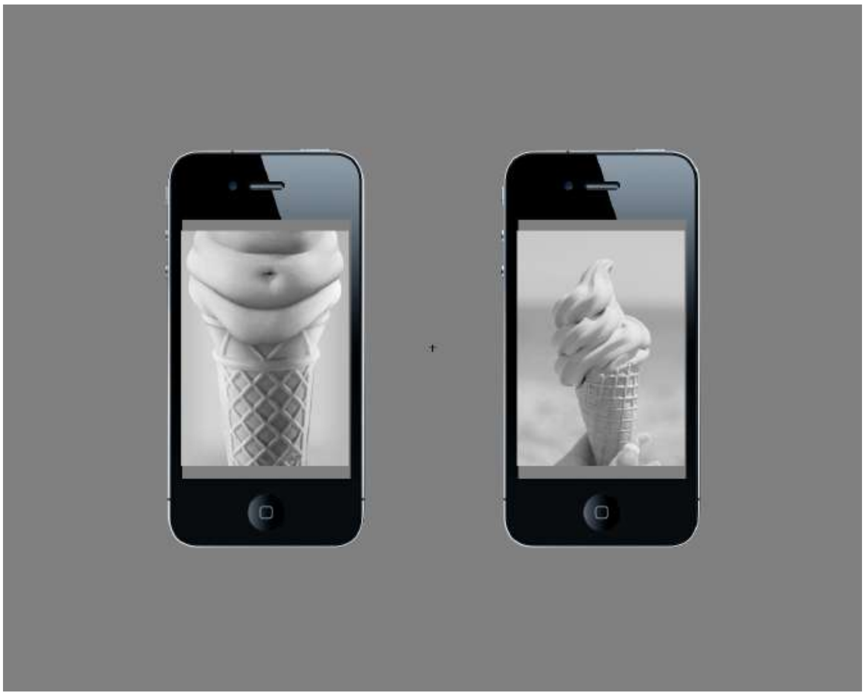


Figure 4 – Example of memory test stimuli through app-like display

EEG data pre-processing

EEG data was filtered from 0.1 to 40 Hz, with an additional notch filter at 50Hz, and then segmented into epochs staring from -1000ms up to 2000ms with respect to image onset time. Due to a defective mastoid reference, we did not re-reference off-line and maintained the on-line reference. After an initial visual inspection of the dataset, it became clear that it was highly contaminated by artifacts due to excessive horizontal eye-movements and blinks. Therefore a decision was made to proceed with artifact removal by independent component analysis (ICA) using the FieldTrip toolbox (Oostenveld et al., 2011). ICA is a computational method for separating a multivariate signal into additive subcomponents, and it is often used to remove EEG eye artifacts. We removed based on excessive noise that was consistent across the whole time-series. On average we removed two components per participant.

As per the pre-registration document (https://osf.io/wftd7/), our focus was on Theta power (4-8 Hz) at mid-frontal location (Fz, Cz, Fcz) in the time window between stimulus onset (0 ms) to 2000 ms post stimulus. As a baseline, we considered the time window between -750 ms and -250 ms across all 3 stimuli types (incongruent, congruent and fillers). To obtain Theta power, we calculated the Short Time Fourier Transform (STFT) for each epoch (from 50ms to 600ms stimulus locked) using a 500-ms Hanning window in 20-ms steps, in a spectral window from 2 Hz to 40 Hz in steps of 1 Hz. The power (in dB) of the STFT was averaged across trials for each condition separately and for each participant. We exclusively analyzed the Theta power in the range 4–8Hz at a fronto-medial electrodes cluster {Fz, FCz, Cz} (Cohen & Ridderinkhof, 2013; Cohen, 2014).

Statistical analyses

MEMORY TEST behavioral data

For the behavioral memory test we expected that incongruent images would have been remembered better compared to control images (Krebs et al., 2015). Therefore, we compared the group average correct responses in incongruent trials against that of congruent trials using a paired t-test (one tail). We also measured and analyzed group average response times (RTs), similarly as for accuracy. As we did not have a clear hypothesis behind RTs we used a two-tailed t-test. We only considered correct response RTs; we excluded RTs individually with a ±2SD cut off around the individual average RT to remove outlier trials.

EEG Power analyses

We extracted the maximum Theta peak amplitude and latency for each participant and condition in the time window between 50 ms and 600 ms post stimulus, the time window where the Theta effect is commonly analyzed and observed. We then calculated the average amplitude 80 ms (-40 +40 ms) around the peak for each participant and condition. Finally, we compared separately the peak amplitude and latency between congruent and incongruent conditions by running a one-tailed t-test considering, as statistically significant, alpha = 0.05.

Results

EEG test PHASE behavioral data

To ensure there was an equal of balance of male/female responses and left/right key presses in the foil task during EEG acquisition, some analysis was carried out on the behavioral data. The mean percentage of women responses was 49.7% (± 5.3%) and 49.7% (± 4.87%) for left key presses. A t-test showed no significant preference for the key pressed [t(26)= -0.342; P= 0.735] or for the gender selected [t(26)= -0.289; P= 0.775], as expected.

MEMORY TEST phase behavioral data

Both accuracy and RTs were tested for a normal distribution using qqplots to assess whether parametric or non-parametric methods should be used to analyze the data. Both plots produced an approximately straight line, suggesting that both accuracy and RT follow a normal distribution (Appendix 3). As expected incongruent images were remembered more (81% ± 9.6%) compared to congruent images (68% ± 13%) [t(26)=5.74; p=0.001]. Please note that accuracy was overall quite high (74.5%), thus proving that participants were paying attention to the stimuli during the EEG recording (Figure 5). Mean reaction time (RT) for incongruent images was 2.2 seconds with congruent images taking slightly longer to be remembered at 2.4 seconds. This difference was significant at [t(26)=5,74; p=0.0055].

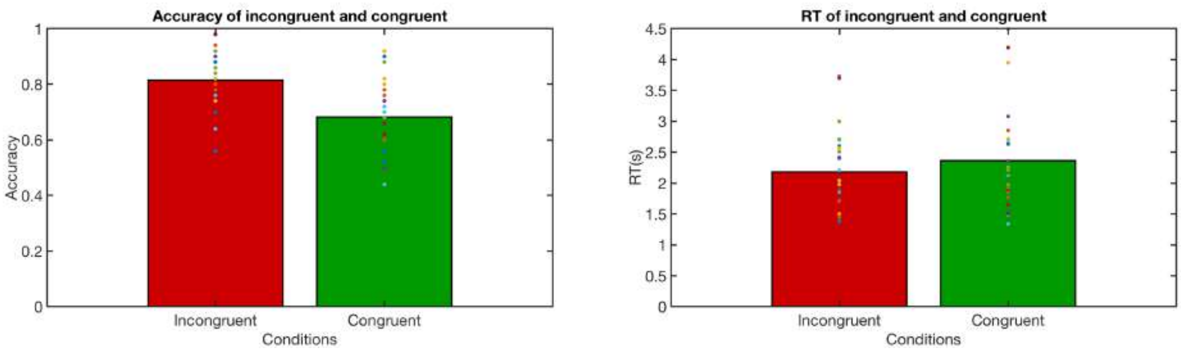


Figure 5 - Memory test accuracy and memory test reaction times (RT) for incongruent and congruent conditions. Bars represent mean and dots represent individual participant results.

EEG Power analyses

We extracted the maximum Theta peak amplitude and latency for each participant and condition in the time window between 50ms and 600ms post stimulus (Figure 6). The difference in amplitude was not significant [t(25)=0.69; p=0.246] but latency was [t(25)=2.09; p=0.047]. Given that latency represents the time taken by the stimulus information to generate the component, and the complexity of the incongruent images could be the reason behind this variability, we decided to explore potential effects in the Theta band across time.

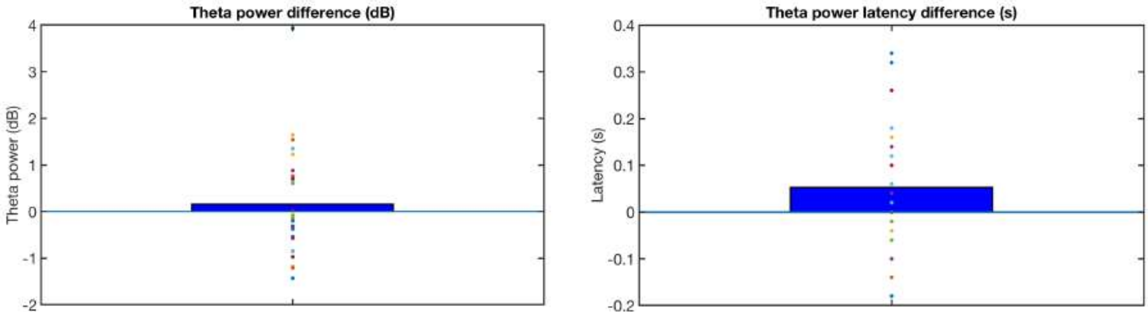


Figure 6 - Plot of the mean Theta power difference (dB) and the mean Theta power latency difference (s) between incongruent and congruent conditions in the time window 50-600ms with individual participant results overlaid in dots.

We carried out further analyses in the temporal window of 150-1000ms (cluster of interest and frequency band are fixed parameters). We excluded the first 150ms from the start in order to exclude transient evoked potentials due to image onset**.** To control for multiple comparisons in time, we used a simulation similar to Guthrie & Buchwald (1991) to estimate how may significant consecutive points it could be possible to find by chance (p<0.05 for 7 or more consecutive points). We performed a point-by-point one tailed t-test comparing incongruent and congruent (incon>con) and found a significant difference in Theta power between incongruent and congruent images in the 370-710ms window, with 19 significant consecutive points (Figure 7).

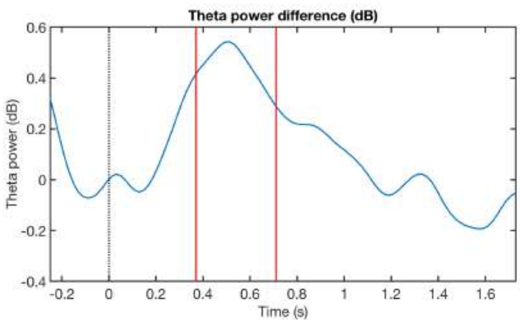


Figure 7 - Plot of the mean Theta power difference (dB) in the time window 150-1000ms. Red lines denote the period of significance, with 19 consecutive points.

To explore whether the increase in activity was concentrated exclusively around fronto-medial locations or whether it was also evident in other brain regions, we carried out a topography analysis (Figure 8B). The color yellow denotes areas of greatest activity and we can see that Theta activity concentrated mostly around fronto-medial locations. It is important to note that the Enobio EEG montage lacked spatial resolution having only 16 electrodes and therefore the overspill of yellow at frontal locations where there was no electrodes, is not reliable.

We plotted a spectrogram to assess whether there was a difference in power across other frequencies (1-40Hz) in fronto-medial locations in our time window of interest (Figure 8A). However, as this wasn't an initial area of interest outlined in the pre-registration document, we didn't explore other frequencies for this thesis.

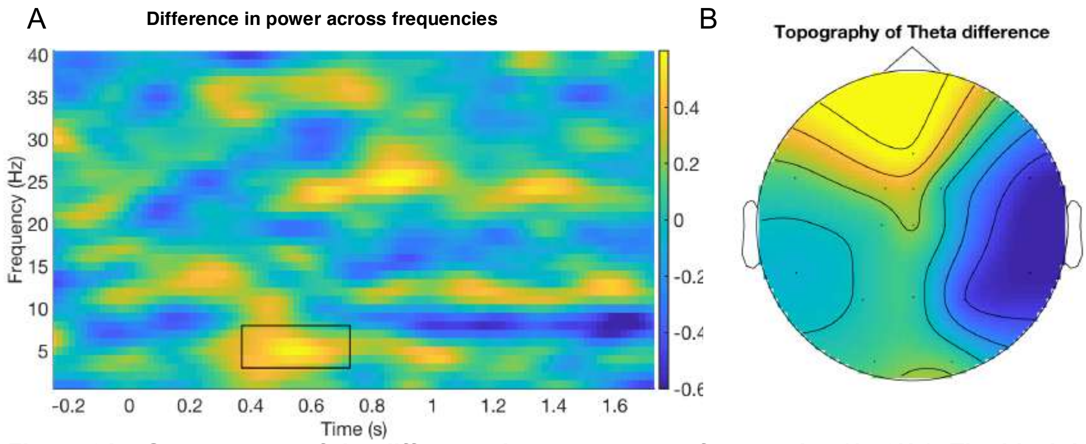
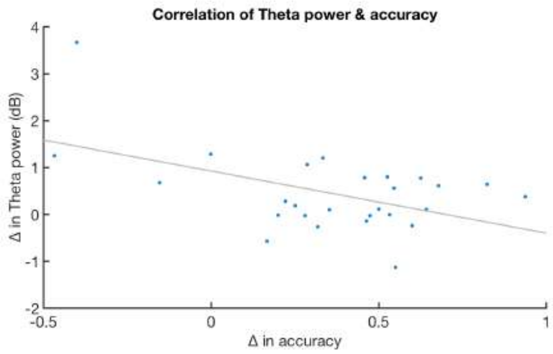


Figure 8A - Spectrogram of the difference in power across frequencies (1-40Hz). The black box indicates the significant period of Theta power in incongruent conditions.

Figure 8B - Topography of the difference in Theta power across incongruent and congruent conditions using 16 electrodes.

Continuing our exploratory analysis, we carried out a trial-by-trial correlation analysis between the behavioral results of the memory test and Theta power. The rationale for this was to discover if Theta power could predict memory performance. The first correlation was with the difference in accuracy between incongruent and congruent conditions compared with the difference in Theta power between incongruent and congruent conditions (Figure 9A). We believed that this would have a positive relationship – as the gap between memory for incongruent images and congruent images increased, so too would the gap for Theta power between incongruent and congruent images. However we found no significant correlation and the relationship was the opposite to what we expected [R= -0.503, P=0.99].

We then carried out a correlation analysis of the difference in accuracy in the incongruent condition compared with the max peaks in Theta power (dB) in the incongruent condition (Figure 9B). Here the relationship was positive as expected, however it was not significant: [R= 0.27, P=0.087].



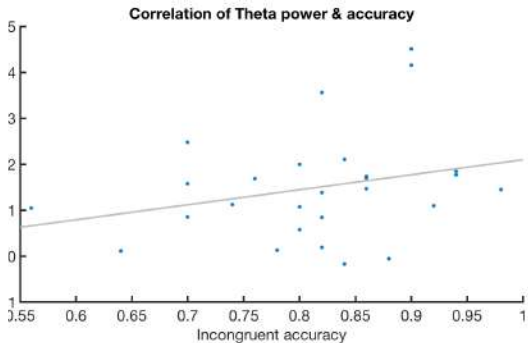


Figure 9A - Scatterplot of correlation of difference in accuracy between incongruent and congruent conditions compared with difference in Theta power between incongruent and congruent conditions.

Figure 9B - Scatterplot of correlation of accuracy in incongruent conditions compared with max peaks in Theta power in incongruent conditions.

Finally, we carried out a correlation analysis in the difference in reaction time (RT) between incongruent and congruent conditions compared with difference in Theta power between incongruent and congruent conditions (Figure 10). We believed that this would have a negative relationship - as the gap between memory for incongruent images and congruent images increased (by way of an increasing negative number) - so too would the gap for Theta power between incongruent and congruent images. The results were as expected and they were also significant [R= -0.39, P=0.022].

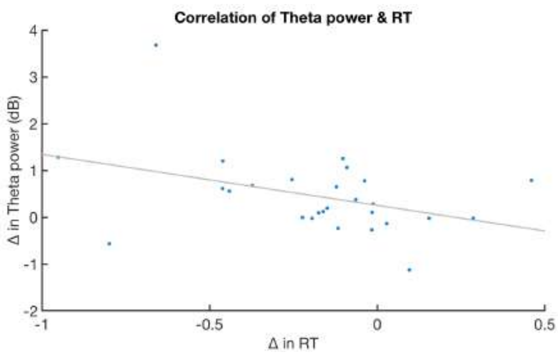


Figure 10 – Scatterplot of correlation of RT between incongruent and congruent conditions compared with difference in Theta power between incongruent and congruent conditions.

Discussion

This study was the first of its kind to test the neural correlates of cognitive conflict in advertising, specifically in surrealist advertising imagery. Participants were exposed to surrealist imagery amongst other ‘normal’ imagery. Furthermore, the idea of the study was to present these images in a realistic context that mimicked social media news feeds – whereby participants were presented with a variety of images some of which were congruent with reality and others were incongruent. Our initial hypothesis was that incongruent imagery would result in increased Theta activity compared with congruent imagery. We based this hypothesis on results showing increased power in Theta activity in classical conflict tasks such as the Stroop Task (Hanslmayr et al., 2008) and a modified version of the Stroop Task that dissociated semantic and response conflict, Jiang, Zhang, & Van Gaal (2015).

As predicted, we found that surrealist advertising imagery not only generates increased Theta activity in mid-frontal locations, it also produces greater memory for those images, a key metric of advertising effectiveness (Keller, 1987). Although we did not find a significant relationship between accuracy in later memory performance and Theta power in conflict and control conditions, we did between RT and Theta power.

To date, most of the studies related to Theta power and cognitive conflict struggle to disambiguate between response conflict and stimulus conflict (Botvinick & Cohen, 2014). Given the nature of our paradigm, we were able to measure pure stimulus conflict, as we only analyzed the evoked response from stimulus, which wasn’t contaminated by response preparation or motor activity. This suggests that a step away from typical laboratory tasks can lead to discoveries that are also of interest to the scientific community, and not just to applied industries. This can be due to new and revised paradigms or simply just through novel stimuli.

This result is of interest to both scientific and creative communities. Conflict generally has negative connotations, as seen in the review by Dreisbach & Fischer (2012) who examine affect and reward in the conflict-triggered adjustment of cognitive control. However, in this study we view it as a positive. A similar concept is discussed in ‘The Effort Paradox: Effort Is Both Costly and Valued’ (Inzlicht, Shenhav, & Olivola, 2018).

According to leading models in psychology, neuroscience and economics, both physical and mental effort is costly and when given the option we tend to avoid it. However, both humans and animals tend to associate effort with reward and therefore the same results may be more rewarding if more effort is applied. In terms of this research, although the incongruent images required extra processing effort by means of increased Theta activity in mid-frontal locations, this could have resulted in reward, which then subsequently led to increased memory. Given that the studies mentioned by Dreisbach & Fischer (2012) mostly focus on response conflict, this could indicate that stimulus conflict is generally positive, as there is no behavioral consequence for processing a stimulus incorrectly, however there can be for incorrect responses.

If we could draw the conclusion that stimulus conflict is always positive, then perhaps we could say that cognitive conflict is a necessary ingredient for creative effectiveness. However more research in this area would be required before making such claims. Future areas of research could include whether language-based paradoxes, also generate cognitive conflict. The results by Robertson et al. (2000) suggest this might also be the case – they found evidence of conflict occurring at a conceptual level by having participants read stories that do not form an integrated narrative. An example of this kind of conflict is an insurance advertisement from Swiss Life as seen below (Figure 11). However language may prove more difficult to standardize across stimuli compared to imagery.

Figure 11 - Sample verbal paradox

A possible limitation of the study was the use of the Enobio EEG headset with 16 electrodes which resulted in less spatial resolution that a standard 32 electrode set-up, as evidenced by the Theta topography (Figure 8B). However, although this is a limitation for science, the fast and easy portable montage makes it more agile and applicable to real-world testing outside the laboratory. Future research using similar study setups may help to merge the scientific and creative communities further and uncover more insights into conflict's relationship with creativity.

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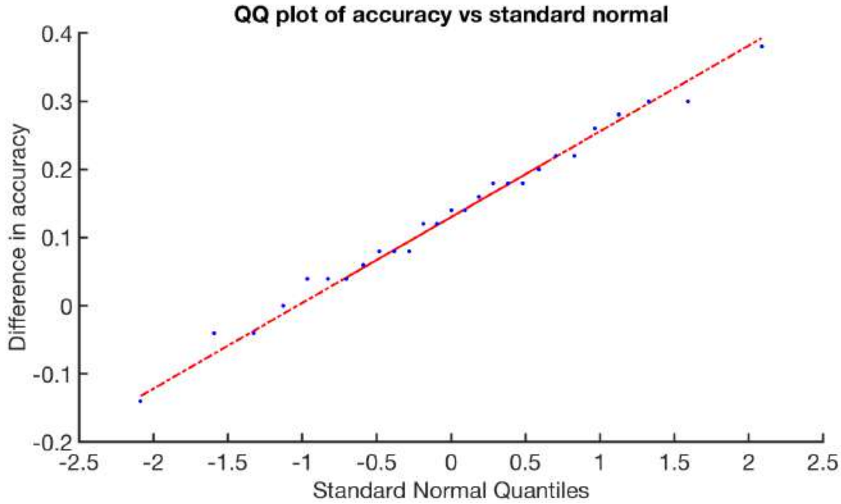
Appendices

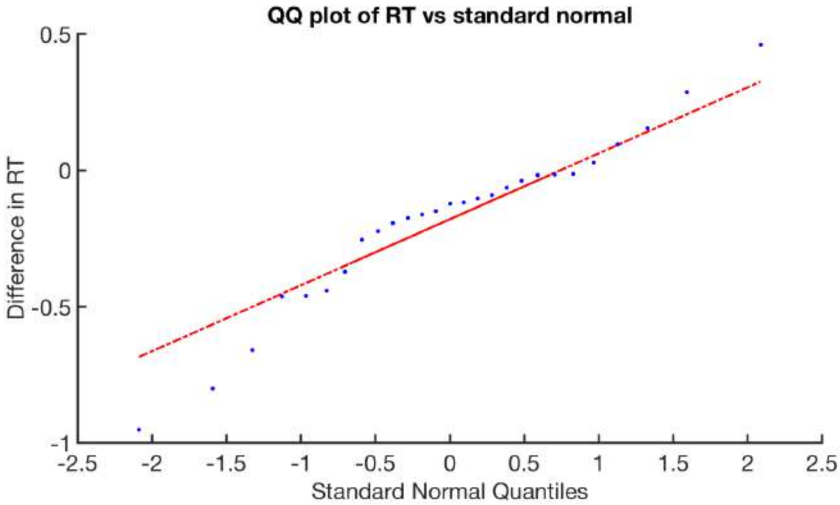
1. Example stimuli pairs - EEG

2. Example stimuli pairs – Memory test

3. QQ plots of the difference in accuracy & RT

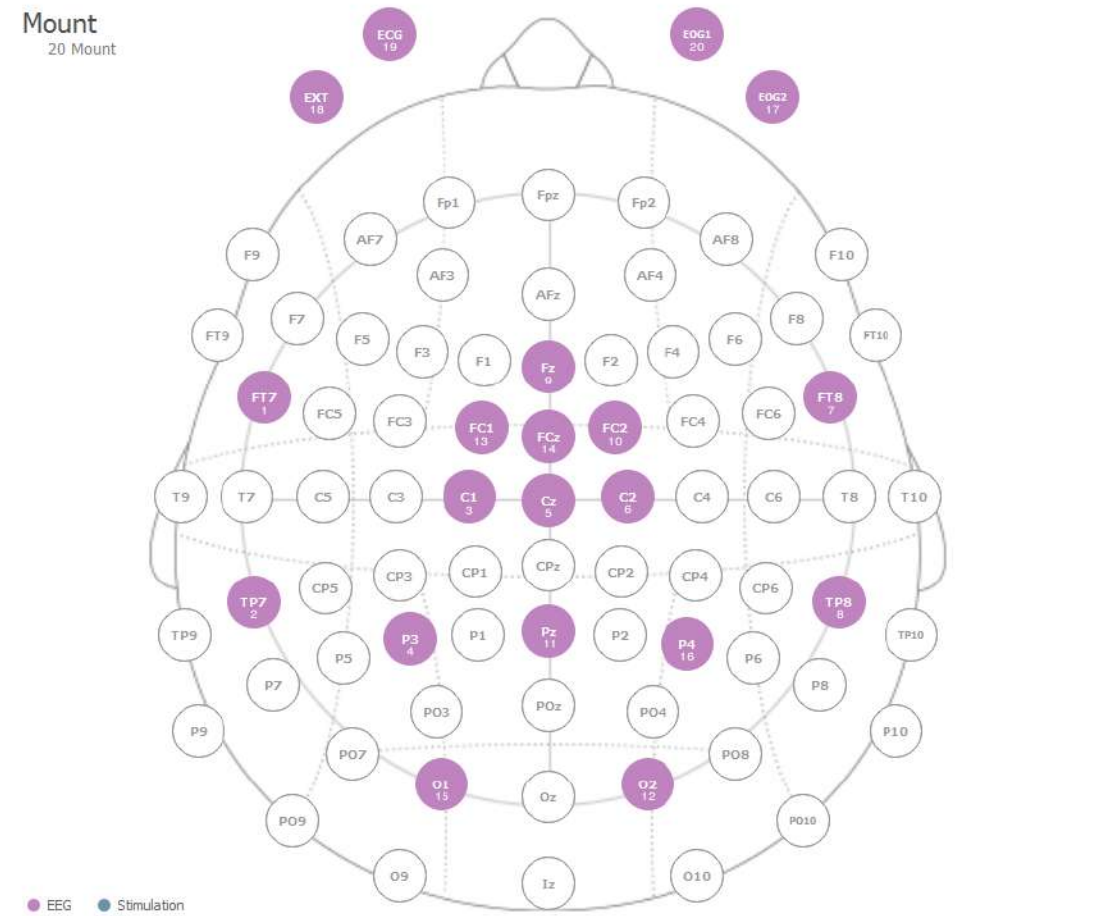


QQ plot of the difference in accuracy in incongruent and congruent conditions versus standard normal. No strong deviations from the line suggest the dataset follows a normal distribution.



QQ plot of the difference in reaction time (RT) in incongruent and congruent conditions versus standard normal. No strong deviations from the line suggest the dataset follows a normal distribution.

4. Enobio EEG montage



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