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Processing of faces in a think/no-think paradigm using a recognition test with accuracy and response latency measures

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Abstract

This study aims at using facial material to see if the material can be remembered and intentionally forgotten through a think/no-think task in which participants are cued to think about some face pair combinations and not think about other face pairs combinations. To do this a think/no-think paradigm is used. An experiment has been conducted in which the participants learned pairs of faces (one male and one female). After this a think/no-think task followed in which only the first face (cue) of the pairs was shown and the subjects were either instructed to remember (think condition) the second face (target) or to suppress it (no-think condition). A third group of face pairs functioned as a baseline and did not appear in the think/no-think task. In the final phase of the experiment the target faces were presented in a recognition test in which half the faces were completely new faces and the other half were old target faces (think, no-think and baseline). The participants' assignment was to differentiate between the old and the new faces. During the recognition test the response times for the correct answers of the old faces were also measured. The hypothesis of this study was that the subjects would be able to remember more of the think condition faces and less of the no-think condition faces compared to the baseline condition, and that the response times would be faster for the think condition and slower for the no-think condition compared to the baseline condition. No hypothesized effects were found in the accuracy and response times of the recognition test. Surprisingly an effect was found in the accuracy of the recognition test in which the baseline condition faces were better remembered than the think condition faces.

Keywords: Memory, think/no-think task, intentional forgetting, recognition test, facial material.

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Introduction

Background

"In the practical use of our intellect, forgetting is as important a function as recollecting."

– William James

The thought that not only recollection but also forgetting is important to our memory processes was not foreign to the pioneers of psychology. We are all aided by our ability to recollect in our daily lives. We are likewise also aided by our ability to forget. In our everyday lives we may appreciate our aptitude to remember such things as where we left our keys in our house, or where we parked our car outside our workplace, while we at the same time may disdain when we unintentionally forget our keys or do not remember where we parked our car. Forgetting can on the other hand also be useful as for example for people who suffer from traumatic memories of past shocking, painful or violent events. In order to overcome past negative memories individuals can reframe their own memories, focus on how they have grown from the experiences, remember only that which is beneficial and suppress all negative associations to the event itself. While unintentional forgetting is a failure to remember, intentional forgetting seems to be a strategic memorial function (Wylie, Foxe & Taylor, 2008). A key element of intentional forgetting is retrieval inhibition. This means that when people are cued to forget already learned information a process initiates that inhibits subsequent retrieval of the to-be-forgotten information (E.L. Bjork & Bjork, 2003).

Within the field of psychology knowledge of how we as humans function and how our brains work can be obtained in several different ways. None of these ways is to be considered an ultimate road to attain the whole truth of the workings of the human mind. All the ways should rather be seen as complementary approaches that try to explain different parts of the not yet acquired knowledge from different points of view. There are different ways to conduct research and all ways are valuable in their own right.

One approach is the phenomenological approach which dictates that individual subjectivity is of foremost importance, and that eventual generalizations and classifications do not always have to be in the forefront of the research process (Sages, 2003). What is sometimes seen as the opposite of this is the scientific method that tries to find the generalizing and objective through measurability and empiricism. Both approaches have interesting aspects and their own fallibilities. For this study I have chosen to use the empirical

approach. By using the same approach as previous researchers one may help forth the search of knowledge in several ways. It may be that the previous studies within the subject were on to something, and that they found an approach that is actually the closest to explaining the actual circumstances of how our brains function. Furthermore, by using an experimental approach a hypothesis can be tested and falsified. The application of a totally new approach to research, as for example the phenomenological approach, would demand a reconsideration of all previous research within memory and intentional forgetting which would be a huge task covering more areas and taking more time than a master thesis would allow. No single study can singlehandedly explain and cover the whole subject of memory, but it can hope to shed some new light that encourages others to make their own contribution to the field.

Intentional forgetting and inhibitory control

Studies regarding forgetting have taken considerable steps in explaining the processes underlying the different types of forgetting since the days of William James. The basic understanding of how forgetting can be intentionally induced originates in the observations of how we are able to stop our own physical action responses. Once a motor behavior response is started it can usually also be stopped. In order to stop a strong habitual response to stimuli and to override it, it is thought to take executive control (Anderson, 2005). The same is thought to underlie our ability to stop a proponent memory from reaching awareness, and our ability to distinguish between competing memory traces and retrieve the memory that is most wanted. The apparatus that sub-serves successful intentional forgetting has by many been attributed to executive control (Zacks, Radvansky & Hasher, 1996; Anderson & Green, 2001; Anderson & Kuhl, 2004; Depue, Banich & Curran, 2006; Hourhian & Taylor, 2006; Wylie et al., 2008; Hanslmayr, Leipold, Pastötter & Bauml, 2009; Mecklinger, Parra & Waldhauser, 2009).

In the same manner that the theory of intentional forgetting grew out of observations of action inhibitions and developed into a theory of memory inhibition, some of the methods within the intentional forgetting paradigm developed out of methods that were made to show the effect of action inhibition in an experimental setting. This applies especially to the think/no-think paradigm which was developed and adapted from the go/no-go task which is a method that demonstrates the effects of inhibitory control in management of overt behavior (Anderson, 2005). In a go/no-go task subjects react to frequent stimuli (go) that is presented before them and withhold their reactions to stimuli that is less frequent (no-go). The

fact that subjects with frontal lobe damages (Drewe, 1975) and subjects with attention deficit hyperactivity disorder (Vaidya, Austin, Kirkoriau, Ridlehuber, Desmond, Glover & Gabrieli 1998) show that they are less capable of inhibiting responses in the no-go condition than other populations gives rise to the assumption that cognitive control is an important aspect and ability in inhibitory control of habitual motor responses. To be able to test if inhibitory control works in a similar way for memory representations the go/no-go paradigm was adapted into the think/no-think paradigm (Anderson & Green, 2001).

The question regarding how exactly strong habitual responses are controlled remains to be answered. A widely discussed answer is that inhibitory control is used to suppress responses caused by habitual thinking. When a stimulus in the environment appears it triggers a memory representation in our minds that corresponds to the stimulus at hand. This memory representation has most likely been linked to the stimulus on previous occasions. Following this, activation will spread to every associated response and these responses will compete to reach a threshold first and be emitted. The response that has the strongest association with the memory representation will most likely achieve the threshold the quickest and therefore also be the one that is emitted. However, this chain of events does not always have to occur. Inhibition can be recruited to reduce the activation level of a response, withholding it from achieving threshold. This will enable a weaker, but perhaps more appropriate response to achieve the threshold before (Anderson, 2005).

Think/No-Think paradigm

In the think/no-think paradigm subjects first study pairs of items in an initial learning phase. In the end of the learning phase the subjects are presented with one of the items (cue) and instructed to recall the other associated item (target). When participants can recall the majority of the target items following the cues they can go over to the next phase: the think/no-think task. In this task the subjects are only presented with the cue items. For some cues the instruction is to remember the associated target item (think condition), and for some the instruction is to suppress the associated target (no-think condition). For the no-think condition the instructions are to avoid a vocal response and to avoid letting the target item to enter conscious awareness at all. This means that the subjects are performing an override to a cognitive act of retrieval. A third condition (baseline) wherein the item pairs are only showed

in the learning phase is also used (Anderson & Green, 2001; Dupue et al., 2006). In the last phase the subjects are again presented with all the cues from all three of the conditions (think, no-think and baseline) and are asked to recall the correct target items. Recall performance was found to be significantly higher for the think condition compared to the baseline. At the same time the recall performance for the no-think condition compared to the baseline was significantly worse indicating that the target items were suppressed by inhibitory control during the no-think task (Anderson & Green, 2001). The more often subjects suppressed retrieval of the target item in the no-think task, the harder it was for the subjects to recall the target item in the last recall phase. Recall directly corresponded to the amount of times (0, 1, 8, or 16) the control functions had been recruited to either suppress or think of the target items in the think/no-think task (Anderson & Green, 2001; Levy & Anderson, 2002).

Furthermore it has been shown in previous think/no-think tests that the memory impairment in the no-think task was cue independent, meaning that target words were harder to retrieve even when a semantically similar word to the target was used as a cue (Anderson & Spellman, 1995; Anderson & Green, 2001). This indicates that memory impairment is not due to associative interference, which is caused by competition between different memories, but that it is better explained as suppression of the excluded memory (Anderson, 2005). The cue-independence found in think/no-think experiments (Anderson & Spellman, 1995; Anderson & Green, 2001) has been the main argument to why interference between competing memories cannot be the cause of the found forgetting. This explanation is however not the only one.

If the cue item that is presented in the no-think trials of the think/no-think task is associated to some other response during the task, as for example sitting quietly, this new cue-sitting quietly association will serve as a competitor to the original memory between the cue and the target items and forgetting will occur because of the competition between the original and the new association (Tomlinson, Huber, Rieth & Davelaar, 2009). When the original memory is tested with an independent cue, that has not previously been tested and that is associated semantically with the target item, forgetting is still observed indicating that associated interference is not the cause of the forgetting since the original cue that could have formed a new association with sitting quietly is not even used to recall the target item (Anderson & Green, 2001; Tomlinson et al., 2009).

Tomlinson and others (2009) argue that this is only right if a one-stage recall model is used, and that a two-stage recall model, which can explain the forgetting as interference assumes that recall consists of a sampling stage (location of memory) and a

recovery stage (retrieval of memory details). If the cue-target association is well learned it may be unintentionally sampled during the no-think trials. If this does happen a newly learned association could be formed between the target item, and the sitting quietly response during the no-think trials (Tomlinson et al., 2009). In a one-stage recall model the new association is formed between the original cue and the sitting quietly response, while in the two-stage recall model the new association is formed between the target item and the sitting quietly response (Tomlinson et al., 2009). This means that when an independent cue is presented, in the two-stage recall model, there could still be associative interference between the two competitor memories: target item-sitting quietly and independent cue-target item (Tomlinson et al., 2009). This explanation is problematic for inhibition accounts of forgetting since it compromises the usage of recall tests. Other studies that do not use recall tests have however found indications of inhibition through recognition tests (Hicks & Starns, 2004) and through lexical decision tests where response times were measured (Veling & van Knippenberg, 2004), which means that there are other better ways of finding effects of inhibition.

Extensive experiments within the think/no-think paradigm were further made to find evidence of inhibition that alternative accounts could not explain. In control experiments subjects were only asked not to say the target word out loud, and any mention of keeping the target word out of awareness was removed from the instructions. The results from this experiment confirmed that no forgetting effect was present which further illustrated that instructions to intentionally suppress an item trigger inhibitory control and that the participants do not merely withhold their response when instructed to suppress (Anderson, 2005).

Functional magnetic resonance imaging (fMRI) was used in later experiments using the think/no-think paradigm (Anderson et al. 2004). The Anderson and others (2004) experiment contrasted activation of neural systems in the brain between the think and the no-think tasks of the test indicating that a network of regions was more active during the no-think task than during the think task. The network that was activated included the bilateral dorsolateral and ventrolateral prefrontal cortex and the anterior cingulated cortex which is very interesting considering the fact that this strongly overlaps with the activation during motor response suppression in go/no-go tasks (Menon, Adleman, White, Glover, & Reiss 2001). This similarity between the two different tasks supports the possibility that neural systems that are involved in overriding prepotent motor responses are also involved and recruited in the control of memory retrieval (Anderson, 2005). Furthermore it was also shown

that activation in the hippocampal area is reduced during suppression (Anderson et al. 2004), an area that is widely believed to be essential for the formation and retrieval of memory (Squire, 1992). It was shown that the activation in the prefrontal cortex (PFC) is recruited to suppress memory activations in the hippocampal area (Anderson et al. 2004).

Developments within the Think/No-Think paradigm

The think/no-think paradigm has not only been used to investigate the possibility of inhibitory control of word material, but also of other kinds of material that might be more socially salient. One such experiment (Depue et al. 2006) tried to dissolve the components of intentional forgetting when it came to negative emotional content compared to neutral content. Depue and others (2006) conducted two different experiments, one using face-word pairs and the other face-picture pairs to demonstrate that the effects of inhibitory control were larger for negative than neutral items both with verbal and non-verbal material. Other studies such as Hanslmayr and others (2009) used face-word pairs and found a significant no-think effect. All of these experiments have a common ground in that they did not use word-word pairs but rather had faces as cues. This deviation from the original think/no-think tasks comes as a development of the method in order to see how inhibitory control generalizes to different types of material. The argument for using face-picture pairs as in Depue and others (2006) second experiment goes back to the research of Grady and others (1998) that reveals that pictorial stimuli can lead to more salient memory representations than word stimuli can. On top of that, research in pictorial stimuli may be a more interesting research development within the think/no-think paradigm since it has clinical relevance; Individuals with Posttraumatic stress disorder (PTSD) and individuals with Obsessive-compulsive disorder (OCD) report that they have uncontrollable disturbing mental images imposing on their consciousness (Grillon, Southwick, & Charney, 1996; van der Kolk, Burbridge & Suzuki, 1997).

What these earlier studies have not detailed in greater extent is how facial material in itself can be inhibited. In all of these studies the faces have acted as cues whereas words or pictures have been the target stimuli. The fact that Depue and others (2006) have shown that pictorial and word stimuli can be inhibited in a similar way has not only given us answers about the effects of inhibitory control, but has also awoken further questions about whether facial material can be suppressed by the recruitment of control functions. Unlike

word and pictorial stimuli faces represent a unique stimuli that are highly relevant and conveying different types of information. Furthermore, perception of faces is arguably the most developed visual perceptual skill in human beings, and a perception skill that is also highly important in social interactions (Haxby, Hoffman, & Gobbini, 2002). From an early age in development children prefer to look at faces instead of other objects. This type of preference is believed to begin shortly after birth for humans (Morton & Johnson, 1991). Moreover, infants at a very early age begin to imitate facial expressions which further implies that face perception is a very important skill and central in the social development of children (Haxby et al., 2002). What makes perception of faces and face stimuli even more interesting is that there is a believed dissociation between neural systems that mediate face recognition and recognition of objects. This has been measured during neuropsychological studies on patients with prosopagnosia (Hecaen & Angelergues 1962; McNeil & Warrington 1993), which is an impairment of an individual's ability to recognize familiar faces. While these patients have an impaired ability to recognize faces, their ability to recognize other objects is relatively intact (Haxby et al., 2002). If inhibition is a really robust occurrence within the think/no-think paradigm, inhibitory controls should be able to be recruited to suppress even facial material that seems to be functioning within specialized systems within the human brain.

Other studies that have used non-verbal material have been able to find a no-think effect. This effect has been found on face-picture material in Depue and others (2006) second experiment where faces were only used as cues and pictures of objects were used as stimuli. The natural next step to build upon this knowledge, of how inhibition functions, would be to examine the effects of face-face pairs. This is especially imperative since current research development in face recognition studies tells of the importance of face recognition in the social everyday life of most human beings (Haxby et al., 2002). It is not far-fetched to believe that if remembrance of faces is really important in human lives, that forgetting and inhibitory control also play an important aspect. People that have experienced past shocking, painful or even violent events might associate certain others to these events, be it as victims of crime or simply from wounds of past personal relations. In all these situations, no matter how much the individual suffers, a common denominator exists in that people wish to be rid of memories of certain faces. By using facial material in a think/no-think paradigm the research could contribute to making an abstract research model more concrete and more applicable to what people need to overcome problems in their everyday lives.

The usage of facial material in recognition studies has in previous research allowed researches to focus on how the components of emotionality (Treese, 2009) affect our ability to remember. Similarly the Depue and others (2006) study that used facial material to investigate the components of inhibitory control found that emotionality was an important aspect of the experiments. Emotions of course play an important role in memory formation of faces (Haxby et al., 2002), but the first step of examining if there are any think and no-think effects in facial material to begin with, would be to use material that is neutral in content. Depue and others (2006) way of regulating emotionality was through the word and pictorial stimuli while the facial material was controlled for as neutral. This gives a basis for precedent usage of neutral facial material in the think/no-think paradigm.

Recognition tests and response latency measures

In a basic recognition test stimuli is presented during a study period. After a while the same stimuli is presented again, plus other stimuli that have not been presented before. Participants' task is to pick the stimuli they remember being presented with before (Goldstein, 2008). Using a recognition test within the think/no-think paradigm is basically the same with some essential differences. When the participants have learned the facial material and performed a think/no-think task they will conduct an item recognition test in which only the target faces will be presented, plus other faces that have not been presented before.

By using a recognition test instead of a recall test the experiment is not only made more practical – a recall test would mean that the subjects would either have to draw a picture of every target stimuli or describe every target item in great detail – but also because there are precedent studies within the subject of inhibitory control that argue that the use of a recognition test instead of a recall test is in fact a better indicator of inhibition (Veling & van Knippenberg, 2004). Recall tests can be problematic and interference theories claim to explain the occurrence of forgetting, even when tested with independent cues, with interference rather than inhibition in two-stage recall (Tomlinson et al., 2009). In an item recognition test where only the target items are presented during the final phase the formation of a supposed target-sitting quietly association that is spoken of in Tomlinson and others (2009) two-stage recall is irrelevant because even if formed, this association would not be in competition with other associations in the recognition test. The recognition test instructions are simply to tell if the presented faces have been previously seen in the experiment and not to

engage recall of the whole original association. Interference theories are generally thought to have fewer explanations for the forgetting that happens in recognition tests (Hicks & Starns, 2004).

The term *inhibition* is best defined and described as a reduction in the level of activation of a memory representation (Perfect, Moulin, Conway, & Perry, 2002). This definition of inhibition leads to the conclusion that recall tests are not the most suitable to determine if forgetting effects are in fact caused by inhibition. Using response latency measures in which subjects are instructed to react as fast as possible to presented items, as in a recognition tests, provide response latencies that are more indicative of the activation level of different items (Veling & van Knippenberg, 2004). This method of determining the effects of inhibition has previously mainly been used within the retrieval practice paradigm (Perfect et al., 2002; Veling & van Knippenberg, 2004; Hicks & Starns, 2004) while the think/no-think paradigm has seen a lack of implementation of this method. The fact that recognition tests have not been used within the think/no-think paradigm opens up new ground within the field of inhibition research. The retrieval practice paradigm, in which recognition tests have mostly been used, is basically different from the think/no-think paradigm on the level of explicitness of the forgetting instruction, the instruction is more indirect in the retrieval practice paradigm. The inhibitory control that takes place within both paradigms of forgetting is basically the same, in the sense that the inhibition is retrieved by executive control (Anderson, 2005), which means that the think/no-think paradigm could benefit greatly from applying research developments, such as recognition tests, from the retrieval practice paradigm.

In a recognition test the participants have to answer if they have seen the presented faces in the test earlier or if the faces are completely new to the test. One half of all the presented faces in the test are old faces (baseline, think and no-think) and the other half are completely new faces that the participants have not seen before. It is enough to use the correct answers for the old faces (hit rate) to determine if there are any think and no-think effects, because these results are the only ones interesting to the study hypothesis, but these correct answers could potentially be misleading if the subjects' do not perform the test in an adequate way. The participants could be bad at discriminating between old and new faces and they could have a bias in their guesses, either for old faces or new faces. For this reason the whole field of recognition tests has developed certain theories and methods for determining how good subjects are at discriminating the cues, in this case faces, and for determining how much of a bias there is in the results. All of the theories use the component of false alarm rates

in determining how well the recognition test has been performed. The false alarm rate is found by looking at how many times the subjects have answered old for new faces.

Two-high threshold model is a model within *signal detection theory* that has the most sensitive bias measure (Snodgrass & Corwin, 1988) which is why it is chosen to determine the discrimination and bias in this studies recognition results. For the measurement of discrimination the *two-high threshold model* uses the measure Pr (values closer to 1 than 0 indicate better discrimination between old and new cues), and for the measurement of bias the model has the measure Br (values above 0.5 indicate a preference for guessing old, and values below 0.5 indicate a preference for guessing new). For the recognition test results to be useful the results will have to be above 0.5 on the Pr measure and below 0.5 on the Br measure, meaning that the participants will have to be able to discriminate between the different cues and have a preference for guessing new rather than old (conservative bias) for the faces.

Study hypothesis

If inhibition is a robust phenomenon within the think/no-think paradigm evidence of forgetting should be found when subjects are instructed to suppress facial material. We frequently encounter different people in our daily lives. Faces are socially salient and something that we frequently process, remember, retrieve and also forget. To conduct a study and research on whether facial material can be intentionally forgotten does not only give us a basic understanding of how we process a very salient cue from our environment, but also helps us determine whether this knowledge can be of use for individuals who wish to forget past shocking, painful or violent events in which the memory of other people is detrimental.

The main focus of this study is to explore uncharted parts of the workings of intentional forgetting by examining whether a think and a no-think effect can be found within the think/no-think paradigm using facial material and a recognition test with accuracy and response latency measures. More specifically this study aims at disclosing whether the stimuli material (faces) will affect participants' ability to suppress in the no-think condition in contrast to a baseline condition and whether the stimuli material will affect participants' ability to remember in the think condition in contrast to a baseline condition. The specific aims are also to disclose whether the response times will be faster for the think condition and slower for the no-think condition compared to the baseline condition.

The hypothesis is that both the think and the no-think effects will be found in the

facial material because the effects have been found in similar studies that use word material (Anderson & Green, 2001) and face-word and face-picture (Depue et al. 2006) material. The fact that the experiment uses a recognition test with both accuracy and response latency measures increases the aptitude of the test to find the effects (Veling & van Knippenberg, 2004).

Besides the use of the experiment to resolve whether the think and no-think effects can be found in the facial material, a set of questions from a questionnaire are also used to determine how the participants subjectively experience the think/no-think task. The questions were selected so that they would be able to represent and answer for the overarching questions: How well did the participants follow the instructions for the think/no-think trials and how did this correlate with the experiment results? What kind of strategy did the participants use to suppress during the no-think trials and how did this correlate with the experiment results? What kind of strategy did the participants use to remember during the think trials and how did this correlate with the experiment results?

The questionnaire is used because previous research has shown that the usage of certain strategies helps increase the chances of forgetting in the think/no-think task (Hertel & Calcaterra, 2005; Bergström, de Fockert & Richardson-Klavehn, 2009). According to some studies subjects are better at forgetting in the no-think trials if they use a strategy of associating the original cue with a new target instead of merely trying to keep their consciousness empty (Hertel & Calcaterra, 2005). Other studies have on the other hand indicated that forgetting is better if a direct suppression strategy is used than if a thought substitution strategy is used (Bergström et al., 2009). Because only the direct suppression strategy has shown to be cue-independent in previous research (Bergström et al., 2009) the hypothesis is that if the results indicate a no-think effect it is also highly likely that a strategy of holding the consciousness empty is found.

Method

Participants

39 participants (19 female) took part in the study. The participants were all between the ages of 20 and 32 years (*M*=24.8 years). All of the participants had normal vision, including color vision, and spoke the Swedish language at a native level. All provided written consent and the procedures were approved by the psychological institution at Lund University. For their participation in the study all participants received a movie gift card of an equivalent value of 70 SEK. 3 of the 39 participants were excluded because they did not manage to understand the test instructions fully and/or did not remember more than 50% of all the faces in the learning phase.

Stimuli

72 faces were chosen from a database (Treese, Brinkmann & Johansson (2003) on the basis that they were already controlled neutral for emotionality within the database. 36 of the faces were male and 36 were female. The pictures were cropped out so that only the face itself, without the hair, was seen. The pictures were randomly paired into male-female, female-male pairs and counterbalancing measures were taken so that the faces would not always appear in the same pair and so that all of the faces would appear an equal amount of times in all of the three different conditions (baseline, think, no-think) and among the new faces in the recognition test.

Stimuli were presented using E-Prime software (Psychology Software Tools, Inc.; Pittsburgh, PA). Responses were gathered by letting the subjects answer the task questions on a computer. Each participant was given a secluded place to conduct the experiment, and if several subjects conducted the test at the same time screens were raised on the sides so that they would not interfere with each other. The participants were briefed beforehand so that they understood the instructions of the experiment and they conducted a training phase of 4 face pairs before the learning phase and a training phase of 4 individual faces before the think/no-think and recognition phases of the test.

Procedure

The experimental paradigm used in the experiment was a think/no-think paradigm. Subjects

learned 24 face pairs. During the learning phase, participants were first presented with a inter-trial interval for 800 ms, then a fixation cross for 400 ms, followed by a blank screen for 400 ms. Following this the participants were allowed to see the face pairs for 3000 ms. This procedure was repeated for every face pair.

During the test feedback part of the learning phase the participants were asked if they could recognize the correct face pairs. They were presented with 48 face pairs, of which 24 pairs were the correct pairs from the learning phase. This test feedback was presented as an associative recognition test, meaning that the participants were presented with whole pairs and had to determine if the pairs were either seen in the learning phase (old) or if they were newly constructed pairs (new). The new pairs in the test feedback were constructed by using old faces from the learning phase but reconstructing them into newly formed pairs. This means that the participants were tested for if they could remember the whole old pair, and not just the individual faces. During the test feedback the participants were presented with an 800 ms inter-trial interval followed by a 400 ms fixation point and a blank screen for 400 ms. Following this the face pair was presented for 3000 ms in which the subjects had time to respond if the pair was an old pair from the learning phase or a new combination of faces. The responses were made on the computer keyboard by pressing either a key designated for old pairs or another key designated for new pairs. For every wrong answer the subjects were presented with the correct answer for the face pairs on the screen before the procedure moved on to the next face pair. Once the subjects managed to answer 80% correct on the test feedback part they could advance to the think/no-think task. If the participants could not reach the 80% mark the whole learning phase was repeated a maximum of three more times, both learning part and test feedback part. When the subject finished their fourth test feedback part they could advance to the think/no-think task if they could recognize at least 50% of the face pairs.

The next phase of the experiment was the think/no-think task in which the subjects were presented with a green frame (think condition) surrounding the picture of one face or a red frame (no-think condition) surrounding the picture of another face. These faces were the cue faces from the learning phase and the subjects were instructed to either try to remember the target faces (think condition) or to actively inhibit the target faces (no-think condition). Sixteen trials were used in the think/no-think task which means that each of the faces was presented sixteen times. First an inter-trial interval was presented for 400 ms before a fixation cross was shown for 400 ms followed by a blank screen for 400 ms. After this the

face with either a green or a red frame was presented for 2000 ms.

One third of the face pairs from the learning phase were not presented during the think/no-think task and worked as a baseline condition in the experiment. In the last phase of the experiment the participants performed a recognition test in which all the target faces from the three different conditions (think, no-think and baseline) were presented. On top of these old faces a set of completely new faces were also presented in this task and the subjects were asked to differentiate whether the faces were old faces that has been seen previously in the experiment or if they were completely new faces. While the participants were presented with the cue faces in the think/no-think task, they were presented with only the target faces in the recognition test. The responses were made on the computer keyboard by pressing either a key designated for old faces or another key designated for new faces.

During the last phase of the experiment, the recognition test, participants were once again presented with a 400 ms inter-trial interval followed by a 400 ms fixation cross, and a 400 ms blank screen. Following this the face was presented for a maximum amount of 2000 ms. No matter if the subjects answered correctly or incorrectly the procedure would automatically proceed to the next face. The participants were instructed to answer the recognition test as quickly as possible for every face so that the response times could be measured.

All the faces were randomized so that they appeared in different face pairs (male-female) for all the participants. All pairs used in the study were either male-female or female-male, which means that all of the pairs had one face of each gender and that both male and female faces were equally distributed to be cue stimuli and target stimuli. All the faces were distributed so that they would appear an equal amount of times in the three different conditions (think, no-think and baseline) and as new faces in the recognition test over all the subjects.

Questionnaire

In addition to the experiment a short questionnaire was also used to understand how the participants subjectively reflected on their own thoughts during the think/no-think task. The participants answered the questionnaire (see appendix) after they had concluded the whole experiment. The first two questions of the questionnaire were regarding the no-think trials and were designed to show how well the subjects followed the given instruction (no-think

compliance). Question 3 and 4 were designed to show what kind of strategy (no-think strategy) the participants chose in their attempt to inhibit the target face that was not shown. Question 5 was designed to show how well the subjects remembered the face as being a part of a pair in the think trials (think compliance). Questions 6 to 9 were designed to show what kind of strategies (think strategy) the subjects used in remembering the face pairs.

For every question the participants were given five different options: “Never”, “Rarely”, “Sometimes”, “Often” and “Very often”. By marking one of the options for every question the subjects gave their answers. The answers also had a corresponding numerical value ranging from 0 (Never) to 4 (Very often).

The participants' results for questions 1 and 2, which were both part of the no-think compliance, were added together to give no-think compliance a scale of 0 to 8 where 0 is the highest compliance and 8 is the lowest. The participants' results for questions 3 and 4, which were both part of no-think strategy, were subtracted from each other to give the no-think strategy a scale of -4 to 4 where -4 is the highest use of the “thinking of another face or object strategy” and 4 is the highest use of the “keeping the consciousness empty strategy”.

The participants' results for question 5 which was the only question that was part of the think compliance was used with its scale of 0 to 4 where 0 is the highest compliance and 4 the lowest. The participants' results for questions 6 to 9 of which all were part of the think strategy were used to calculate a new scale from -12 (The use of remembering the faces by some specific characteristic) to 12 (The use of remembering the pairs as a couple). Questions 6 to 8 were all part of the “remember the pairs as couples (family member, romantic couples or friends) strategy” while question 9 was the only question that was part of the “remember the faces by some specific characteristic strategy”. For this reason the results for question 9 were multiplied with 3 to make both strategies corresponding to each other, before the scale was calculated.

Following this, a forget variable was calculated by subtracting the participants’ no-think accuracy from their baseline accuracy, and a remember variable was calculated by subtracting the participants’ think accuracy from their baseline accuracy. This was done to correlate the participants’ no-think compliance and no-think strategy with their ability to forget and to correlate their think compliance and think strategy with their ability to remember.

Results

Learning phase

During the learning phase the participants were able to learn 70.7% of all the faces during their last test feedback cycle. The subjects learned 70.0% (*SD* = .11) of all the faces that were to become baseline condition faces in the experiment, 69.1% (*SD* = .15) of the faces of the think condition and 73.2% (*SD* = .14) of the faces of the no-think condition. A repeated measure ANOVA was conducted and no statistical significances were found, F (2, 70) = .219, MSE = .004, $p > .05$, *partial* η^2 = .006, regarding how well the different faces from the different conditions were learned in the initial learning phase, which means that these results did not affect the outcome of the think/no-think task.

Recognition test

The participants were able to correctly recognize 85.3% (*SD* = .11) of all the old face in the recognition test (hit rate). The participants answered old for new faces 9.1% (*SD* = .09) of the time (false alarm rate). The discriminability measure (*Pr* = .761) indicates that the participants were good at discriminating between old and new faces. The bias measure (*Br* = .382) indicates that the participants had a conservative bias, meaning that they had a preference for guessing new in the recognition test.

Table 1
Accuracy results from the final Recognition test

Condition	*Mean*	*SD*
Baseline	0.873	0.144
Think	0.811	0.164
No-Think	0.873	0.150

Note: N (36 for all conditions)

The subjects were generally better at accurately remembering baseline condition and no-think condition faces compared to think condition faces.

A repeated measure ANOVA with the independent variable *condition* (with its three levels: baseline, think and no-think) was conducted in order to find the overall differences between all the different levels on the factor using a planned comparison test. The planned comparison test was used because the experiment hypothesis was interested in determining if there are any differences between the three levels of the *condition* variable.

The significance level for all the statistical tests was set to $\alpha < .05$. The Mauchly's Test of Sphericity was not statistically significant on a $p < .05$ level which means that sphericity can be assumed for the test.

There was no main effect on the memory inhibition factor: F (2, 70) = 2.975, MSE = .015, $p > .05$, *partial* $\eta^2 = .078$. Results from the planned comparisons test indicate that the baseline condition faces were significantly better remembered than the think condition faces, F (2, 70) = 2.861, $p = .022$.

Results indicate that there was no statistically significant difference between the baseline condition faces and the no-think condition faces, F (2, 70) = 2.861, $p = 1.000$. The results also indicate that there was no statistically significant difference between the think condition faces and the no-think condition faces, F (2, 70) = 2.861, $p = .078$.

Table 2
Response time results from the final Recognition test

Condition	*Mean*	*SD*
Baseline	958.116	165.955
Think	939.233	160.958
No-Think	956.795	152.958

Note: N (36 for all conditions)
Note 2: All times are in ms

The subjects were generally faster at answering correctly to the think condition faces compared to the baseline condition and no-think condition faces.

There was no main effect on the independent variable *response time*: F (2, 70) = .378, MSE = 4000.368, $p > .05$, *partial* η^2 = .011. Results from the planned comparisons test indicate that no differences were obtained between the levels of the factor: think and baseline conditions, F (2, 70) = .450, p = .470, think and no-think conditions, F (2, 70) = .450, p = .396, baseline and no-think conditions, F (2, 70) = .450, p = .960.

Questionnaire

To examine if there were any significant correlations between the think/no-think compliances, think/no-think strategies and the remember/forget variables four separate Pearson correlation tests were conducted.

The results indicate that no-think compliance (M = 3.75, SD = 1.795) was not correlated with the forget variable (M = .000, SD = .164), r (34) = .159, $p > .05$. The results indicate that the no-think strategy (M = .11, SD = 1.753) was not correlated with the forget variable (M = .000, SD = .164), r (34) = -.236, $p > .05$. The results indicate that think compliance (M = 2.28, SD = .849) was not correlated with the remember variable (M = -.062, SD = .155), r (34) = -.032, $p > .05$.

The results indicate that think strategy (M = -6.50, SD = 3.402) was significantly correlated to the remember variable (M = -.062, SD = .155), r (34) = 1.00, $p < .05$. This means that the "Remember the faces by some specific characteristic strategy" was positively correlated with the fact that the participants were able to perform better on the baseline condition compared to the think condition.

Discussion

In this study's experiment the think/no-think paradigm was used to examine if it was possible to find indications of a think and a no-think effect in stimuli material solely consisting of faces. Previous research has found the effects in word material (Anderson & Green, 2001) and in face-word and face-picture material (Depue et al. 2006). In the experiment the participants first learned face pairs and were tested for if they knew them before they conducted a think/no-think task in which they were instructed to either remember (think condition) the target face of a pair when presented with the cue face or suppress (no-think condition) the target face of a pair when presented with the cue face. A third group of face pairs functioned as a baseline and did not appear in the think/no-think task. In a final recognition test the subjects were tested for if they could recognize all the target faces (think, no-think and baseline).

The hypothesis of the study was that the participants would remember more of the think condition compared to the baseline condition (think effect) and that they would remember less of the no-think condition compared to the baseline condition (no-think effect). The study also tested and hypothesized that the subjects would be faster at answering correctly for the think condition compared to the baseline condition, and slower for the no-think condition compared to the baseline condition. Furthermore, the study used a questionnaire to resolve how well the participants followed the instructions for the think trials (think compliance) and the no-think trials (no-think compliance) in the think/no-think task. The questionnaire was also used to show what kind of strategy the participants used in the think trials (think strategy) and in the no-think trials (no-think strategy). The questionnaire results were correlated with the recognition test results to see if any correlations existed between the instructions and results and strategies and results.

The two-high threshold model (Snodgrass & Corwin, 1988) was used to test for if the participants were able to discriminate between old and new cues in the recognition test and if they had any bias in their guesses (either liberal bias which would make the recognition test non-usable or conservative bias which would make the test usable).

The results indicate that the recognition test had a conservative bias and that the participants were good at discriminating between old and new cues thus making the test usable. The recognition accuracy test results indicate that the think and no-think effects were not found, but that the baseline condition faces were significantly better remembered than the

think condition faces. The recognition response latency results indicate that the think and no-think effects were not found.

The questionnaire results show that the instructions and the no-think strategy did not correlate with the test results, but that the think strategy did correlate with the results indicating that the poor think condition results were correlated with the participants' usage of the "Remember the faces by some specific characteristic strategy".

No-Think condition

The study did not succeed in finding a no-think effect within facial material neither with the accuracy test nor with the response time measures. The final recognition accuracy test showed that the participants were equally good at remembering baseline condition faces and no-think condition faces. The results from the final recognition response times indicate that the participants were a little bit faster at answering correctly for the no-think condition compared to the baseline condition. Since no statistical significances were found, no decisive conclusions can be drawn from these results besides that the study was unable to replicate the results of previous studies that have been able to find the no-think effect in other types of stimuli material (Anderson & Green, 2001; Depue et al. 2006).

A possible explanation for the lack of effects could be that the recognition tests which have in the past been used within the retrieval practice paradigm are perhaps not equally good fitted for this think/no-think paradigm experiment. Even within the retrieval practice paradigm recognition tests have not always easily found a forgetting effect as can be seen in previous studies (Anderson, Bjork & Bjork, 1994; Lang, 2000). There are yet other studies within the think/no-think paradigm that have shown that the no-think effect might not be the most stable and dependent effect in all types of tasks (Bulevich, Roediger, Balota & Butler, 2006; Bergström, Velmans, de Fockert & Richardson-Klavehn, 2007). Another explanation for the failure of finding a significant no-think effect could be the fact that the subjects may not have followed the experiment instructions in an adequate way. The questionnaire that the participants filled in after their completion of the experiment gives an indication of how they subjectively experienced and followed the instructions. Unfortunately the results from the questionnaire detailing the no-think condition did not significantly correlate with how the participants performed during the no-think task. The average score of the two first questions from the questionnaire that detailed the no-think compliance

corresponds to that the participants *sometimes* did not follow the no-think instructions. This could potentially be enough to affect the outcome of the think/no-think task. Definite conclusions should not be drawn from this result since the correlation between the no-think compliance and the forget variable was not statistically significant. However, the fact that it was common among the participants not to follow the instructions in the no-think trials should be considered as something to work upon in future studies that aim at using a similar method and/or paradigm.

Findings that Anderson and Green (2001) examined showed that there was a linear suppression curve in relation to the number of suppression trials the participants were shown during the think/no-think task. In their experiment they used 0, 1, 8 and 16 trials, which means that each no-think cue was shown 0, 1, 8 or 16 amounts of times during the no-think task. In my experiment only sixteen trials were used, which is supposed to be the most effective way of finding an inhibition effect (Bulevich et al., 2006). However, if the participants in the study happened to ignore the no-think instruction sometimes the sixteen trials are no longer sixteen optimal trials, but rather sixteen compromised trials. The problem could have been avoided by the usage of even more trials in the experiment. This on the other hand could result in greater risks of fatigue for participants which would once again further compromise the trials. Fatigue could be the original cause to the problem of why the subjects sometimes ignored to follow the instructions. The whole think/no-think task takes approximately 10 to 15 minutes to complete in which the participants are requested to remain seated and keep focusing on the face cues that show up on the computer screen.

The no-think strategy results indicate that the participants had a very small preference for using a strategy of keeping the mind empty. This indication is however so small and insignificant that it probably does not affect the think/no-think task. Previous research with recall tests has shown that people who use a strategy of associating one of the cues to another completely different cue in order to suppress the original target actually are better at forgetting than people who do not use this strategy (Hertel & Calcaterra, 2005). Conversely even newer research (Bergström et al., 2009) has indicated that it is the opposite that is accurate, and that a strategy of direct suppression is the only strategy that creates significant forgetting that is also cue-independent. This debate, however interesting cannot be properly answered within the results of this study considering the fact that the no-think strategy results did not correlate with the experiment results.

A potential contribution to the lack of finding of a no-think effect could be that

inhibition is not robust enough as a phenomenon to be found using facial material. Unlike word material or material consisting of pictures of objects, facial material engages a perceptional skill that is one of the most developed in humans (Haxby et al., 2002). Taking this into account there is a possibility that the participants' perceptional skills were too good for any inhibitory control to override and suppress the memories of the faces. Even though the faces were controlled for emotionality there is a possibility for emotional responses to occur (Haxby et al., 2002). Perception of familiar faces is thought to affect the amygdala, a region in the brain believed to process emotions, in greater extent than perception of unfamiliar faces (Haxby et al., 2002). This is especially true for personally familiar faces, family members, friends and even famous familiar faces (Gobbini, Leibenluft, Santiago & Haxby, 2000). There is a possibility that the practiced faces from the learning phase became so well encoded that participants experienced the same level of familiarity which people usually experience when they see familiar faces in everyday life, when they saw the faces in the think/no-think task and in final recognition test. If this happened during the experiment, the control of the emotionality of the faces in the original database may have been overridden and any suppression attempts that the participants attempted in the think/no-think task may have been spoiled by the familiarity, causing the absence of a no-think effect in the final recognition test results.

Think condition

The study was not able to find a think effect, meaning that the think condition was not significantly better remembered than the baseline condition. For the recognition test response times no statistical significance was found between the think condition and the baseline condition. For the recognition test accuracy results think condition performance was found significantly lower than baseline condition performance. This result is surprising since it indicates that the subject were better at remembering baseline condition faces - which were presented in the initial learning phase, not mentioned at all during the think/no-think task and then again presented during the recognition test - than think condition faces - which were presented in the initial learning phase, recovered during the think trials of the think/no-think task and yet again presented during the recognition test. Even if this result was not hypothesized there are some possible explanations that may be able to make clear why it occurred.

The encoding specificity principle speaks about how we can only bring forth that which has been stored in our memory from the beginning. The retrieval possibility of already stored information is however highly dependent on how the information was stored in the first place (Tulving & Thompson, 1973). Another model called transfer-appropriate processing speaks of similar importance of having the retrieval context matching the encoding context for the retrieval to be maximized (Morris, Bransford & Franks, 1977). This principle that has been determined by Tulving and Thompson (1973) is mainly focused on explaining how retrieval errors can occur in memory tests where the subjects are tested on word material. Tulving and Thompson (1973) describe how for example the word *Violet* is highly dependent on the context that it is remembered in. If the word is remembered as a color in an initial memory test the participants will be unable to recall the word if the retrieval cue is the category *flowers* or *girls names* both of which are categories that *Violet* also belongs to (Tulving & Thompson, 1973).

In my study the cues were obviously different since the subjects were presented with faces instead of words, but the same principle could be in effect here too. In the initial learning phase the subjects learned the faces as pairs and were then tested for how well they knew the pairs in an associative recognition test where old and new face pairs were presented. After that, they conducted a think/no-think task in which only the cue faces were presented. For the think condition faces the participants were told to try to remember the target faces. In the end a recognition test was performed in which participants were only presented with the target faces and told to differentiate between if what they saw presented before them were old or a new faces. This item recognition test is not similar to how the subjects initially learned to remember the faces, as a part of a pair, which means that there are differences between the encoding and the retrieval. The learning phase and the final recognition test were however the same for both the think and the baseline conditions, meaning that this does not explain the difference between the conditions.

The difference between the conditions lies in the think trials where think condition cue faces were shown and the subjects had to think of the target faces. This kind of "forced" forward association may have mislead the participants into preparing for and arranging their associative memory in a new way that made the final recognition test more difficult. What is for certain is that the encoding of the think condition faces most probably was diverted in a manner that the encoding for the baseline condition faces was not.

Taking a look at the questionnaire question that was used to examine the think

condition, question 5 by itself was used to test how well the participants were following the given instructions. The think compliance results indicate that the subjects did in fact have trouble following the instruction and remembering the target faces. The results indicate that the participants thought that it was *sometimes* hard to remember the target faces during the think trials. This is an interesting observation that coincides with the compliance results for the no-think trials. The subjects did have difficulties with following the instructions during the whole think/no-think task that lasted for approximately 10 to 15 minutes. In the same manner that the no-think compliance rate did not correlate significantly with the forget variable, so was there no significant correlation between the think compliance and the remember variable. This restricts how definite the conclusions can be regarding the think compliance results, but the fact remains that looking upon the participants as a whole, they did on average have difficulties with following the instructions. Since the participant did follow the instructions sometimes it cannot be interpreted as a lack of understanding of the instructions, but rather as a result of fatigue during the task, absence of concentration or simply that the task at hand had a high difficulty level.

The most interesting part of the questionnaire was the result for the think strategy. The two different strategies that the participants used were either to try to remember the target faces by some special characteristic on the faces, or by trying to remember the cue and target faces as a couple (family members, romantic couples or friends). The results indicate that the subjects more commonly tried to remember the target faces by some special characteristic on the faces. What is even more interesting is that the think strategy correlated significantly with the remember variable which indicates that the participants that used the special characteristic strategy were also worse at performing at the last recognition test for the think condition. The fact that the participants not only failed in showing a think effect, but also succeeded in significantly performing better on the baseline condition than on the think condition in the accuracy results of the recognition test, indicates that the development of a proper strategy during the think trials is crucial in the act of remembering. Considering that faces are highly socially salient cues (Haxby et al., 2002) it is not unlikely that the strategy of coupling, that activates social thinking, would make the participants prevail to a higher extent in the think condition than what they did using the special characteristic strategy.

Final remarks and future steps

The hypothesis that a no-think effect would be found using facial material in the think/no-think paradigm was not fulfilled, meaning that the no-think condition faces were not significantly harder to remember than baseline condition faces. The results indicate that the subjects were equally good at remembering both conditions and that the subjects were slightly faster at answering correctly to the no-think condition compared to the baseline condition. This difference in times was however also insignificant. This leaves the field open to interpretations. Before it can be assumed that the null hypothesis is in fact correct and that it is not possible to find a no-think effect using facial material, other possible explanations have to be examined.

The hypothesis that a think effect would be found using facial material in a think/no-think paradigm was not fulfilled. In fact the opposite effect was found for the relationship between the think condition faces and the baseline condition faces. The participants were significantly better at remembering baseline condition faces compared to think condition faces. The response time results for the think condition and the baseline condition are pointing in a way towards a think effect, but since the response time results were insignificant no such conclusion can be drawn. The fact that the baseline condition faces were significantly better remembered than the think condition faces is puzzling but still explainable.

The encoding specificity principle (Tulving & Thompson, 1973) tells us that memories are easiest retrieved when they are presented in the same manner as they were encoded. The baseline condition faces were first learned as pairs before they were retrieved in an item recognition test in the end where only the target faces were presented. The think condition faces were not only first learned as pairs in the learning phase but also retrieved during the think/no-think task in which only the cue faces were presented. Following this the think condition faces were part of the final item recognition test. The fact that the think condition faces were first encoded and then cued to be remembered without the target faces in the think trials may have disturbed the memory traces and made the participants perform worse during the last recognition test. Furthermore the participants were mostly using a strategy of remembering the faces based on some special characteristic during the think trials, instead of trying to connect the associated faces as couples of some sort (family members, romantic couples or friends). This special characteristic strategy was correlated with the poor

performance in the think condition.

Future studies that implement facial material in the think/no-think paradigm should consider and contemplate the possible explanations for the lack of success in finding think and no-think effects in this study. First and foremost, it is essential that the participants understand and follow the experiment instructions as much as possible. Furthermore, future studies could concentrate on applying a study inquiry on how well different strategies of thinking affect the suppression that is supposed to take place during the no-think trials. Some argue that the strategy of thinking of another object (Hertel & Calcaterra, 2005) is the best, while other studies have found indications that cue-independent suppression only occurs when a direct suppression strategy is used (Bergström et al., 2009). More research on the subject could confirm either of the strategies as the optimal strategy.

Another interesting option for future studies could be to have the participants answer for if they experienced the old faces as more emotional than the new faces in the final recognition test. Even if facial material is controlled for as neutral before an experiment the occurrence of emotional responses to already familiar faces is highly possible (Haxby et al., 2002). Unlike other types of material, facial material in this sense has to have a more rigid control of the emotionality that the participants experience. If a future study finds that subjects experience old faces as more emotional than new faces in the recognition test, without finding a no-think effect, it would give evidence for that familiarity from the learning phase is disturbing the think/no-think task and withholding inhibitory control from being recruited to suppress items in the no-think trials.

Other options for future studies could be to try to examine the absence of a think effect and the finding that baseline condition faces were significantly better remember than think condition faces in this study. This can be done by diving deeper into theories of encoding specificity and determining in what other ways recognition tests can be performed so that they are more in line with how the subjects first learned the material. Perhaps the final recognition test can be adapted as an associative recognition test in which the subjects try to recognize pairs and not just target faces? If the retrieval in the recognition test is similar to how the encoding was in the learning phase remembrance could possibly be better.

Last but not least future studies could focus on applying certain remember strategies for the think condition and test for if they are more likely to lead to a think effect. In this study the participants mostly used a strategy of remembering special characteristics of the faces which lead to poor results in the think condition. An inquire can be made into whether a

strategy of coupling the faces (remembering the pairs as family members, romantic couples or friends) leads to better performance rates in the think condition.

All in all, the results from this study do not have to lead to a dead end in the research of inhibition of facial material. Even though there were no indications of a think or a no-think effect when facial material was implemented in the think/no-think paradigm, the results open up more new doors for future research than they close old ones. Whatever step future studies decide to build upon, our knowledge of the functions of inhibition and memory suppression will deepen for every new question that is asked.

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Appendix

Questionnaire

Question 1: Did you look at the face and then assured yourself that you still knew the associated face, and *then* tried to *not* think about the associated face?

Question 2: Did you try not to think about the associated face, but after the try was over you assured yourself that you still knew the associated face?

Question 3: Did you avoid thinking about the associated face by keeping your conscious completely empty?

Question 4: Did you avoid thinking about the associated face by thinking about something else (another face or some other object for example)?

Question 5: Did you look at the face and thought that it was hard to remember the other face in the pair?

Question 6: Did you associate the two faces in the pair with each other on the basis of how well they would have fitted as a romantic couple?

Question 7: Did you associate the two faces in the pair with each other on the basis of how well they would have fitted as siblings?

Question 8: Did you associate the two faces in the pair with each other on the basis of how well they would have fitted as friends?

Question 9: Did you associate the two faces in the pair with each other on the basis of some certain characteristics on the faces?