Chapter 5 |

Can Illness Memory be Activated by Subliminal Stimulation? Two Validation Studies of Subliminal Priming and Subliminal Evaluative Conditioning

ABSTRACT

Objective We attempted to validate whether the paradigm for subliminal priming and subliminal evaluative conditioning that we used in our previous studies and that is commonly used to prime behavior in social psychological studies, was actually effective in activating semantic memory networks for at least several minutes.

Methods In the first study we subliminally primed participants with either neutral or illness words. We then measured with a lexical decision task whether participants primed with illness words had quicker response latencies for illness words. In the second study, participants were subliminally exposed to either a self-referring word “I” or a nonself-referring word “X” paired with illness words using subliminally evaluative conditioning. We then measured whether participants exposed to “I” and illness words showed stronger associations of the self with illness on an implicit associations task.

Results The priming or subliminal evaluative conditioning did not cause differences in response latencies on subsequent tasks.

Conclusions In both studies, we did not find that the priming techniques were effective in activating semantic memory networks. This study shows that it is important for future studies to include a manipulation check of subliminal priming to see whether it is effective in manipulating implicit memory. In addition, future studies should examine ways in which to make priming techniques more reliable.
INTRODUCTION
In previous studies (Meerman, Brosschot, Van der Togt, & Verkuil, 2013; Meerman, Brosschot, & Verkuil, 2012; Meerman, Verkuil, & Brosschot, 2011) we tested a model of symptom reporting that holds that medically unexplained symptoms (MUS) are at least partly caused by chronically activated illness-related memory networks- or schemata of illness (Brosschot, 2002; Brown, 2004; Rief & Barsky, 2005). The basic rationale is that activated illness memory would lead to increased selective attention towards bodily signals, which in turn causes increased detection of these signals and increased reporting of these signals as symptoms. We have experimentally tested this cognitive model of symptom perception by priming healthy participants subliminally with illness-related words to (temporarily) increase activation of illness-related cognitive memory networks and afterwards examined whether this caused a lower pain tolerance (Meerman et al., 2011). The results of these studies have, however, been inconsistent. In one study we indeed found that pain tolerance was involuntarily decreased by activating illness-related memory, but we could not confirm this finding in a subsequent replication study (Meerman et al., 2012). The question rose whether our methods were sufficiently adequate to draw strong conclusions concerning the tenability of the illness activation model. We started to suspect that our priming method was suboptimal, in that its effects did not last long enough or that the prime stimulus duration itself was inadequate. As to the first possibility, several studies have shown that behavioral effects of subliminal priming can last for at least the duration of a subsequent task, usually several minutes (for example Bargh, Chen, & Burrows, 1996; Levy et al., 2000), and thus long enough for our purpose. With respect to the second possibility, i.e. prime stimulus duration, we used a duration (33 ms) that successfully produced effects before (for example Kiefer, 2002; Levy, 1996; Pierce & Lydon, 1998; Lowery et al., 2007) amongst which long-lasting subliminal priming effects of up to four days (Lowery et al., 2007). Thus, prime duration is unlikely to have caused the negative findings.

It is theoretically possible that priming does have no prolonged memory effects, despite is prolonged behavioral effects. However, several studies have found that priming leads to increased memory accessibility of the primed construct (Aarts, Custers, & Holland, 2007; see for example Aarts & Dijksterhuis, 2003). Our current study set out to test whether our subliminal priming task used in our previous studies was indeed successful in activating illness memory. If illness-related subliminal primes would turn out not to induce prolonged memory effects this could explain our inconsistent findings mentioned above, because the priming effects, if any, might be too brief to have substantial effect on symptom reports.

Since our two previous priming studies (Meerman et al., 2012, 2011) yielded inconsistent results, we conducted a third study using another paradigm, namely an evaluative conditioning paradigm, in which illness memory (illness schema) and self-schema was simultaneously activated. With this paradigm we aimed to investigate whether
symptom reporting would be more strongly affected when illness schema was repeatedly coactivated or ‘enmeshed’ with the self-schema (as suggested by Pincus & Morley, 2001). However, we did not find that such a simultaneous subliminal priming by self- and illness-stimuli increased symptom reporting. The question that remained was whether we actually succeeded in temporarily associating self with illness information. However, several other studies were successful in increasing the association of the self with another concept (e.g. Dijksterhuis, 2004; Riketta & Dauenheimer, 2003). Dijksterhuis (2004) verified the strengthened association between self and positive trait terms (thus temporarily increasing ‘self esteem’) by use of the Implicit Association Test (IAT, see below). In the current study we aimed to do the same for the association between self and illness.

In conclusion, two out of our three priming studies using either subliminal priming or subliminal evaluative conditioning, did not show support for the hypothesis that illness-schemata cause increases in symptom reporting. However, it is unclear whether this is due to a faulty model or due to the subliminal priming techniques being unreliable in temporarily activating the illness-related schemata. In the current studies, we first attempted to validate whether the paradigm for subliminal priming that we used in our previous studies and that is commonly used to prime behavior in social psychological studies, was actually effective in activating semantic memory networks for at least several minutes. This was done using a lexical decision task, which is a standard test to measure spreading of activation of across specified memory content. In the second part of the study we attempted to validate whether the subliminal evaluative conditioning was effective in creating an increased association between the self and another concept. We examined the effectiveness of the procedure by administering an IAT, which is designed for examining the strength of implicit associations. Our first hypothesis was that subliminal priming with illness words causes a significant quicker reaction time for illness words on a subsequent lexical decision task due to an activated illness memory network (study 1). Our second hypothesis was that subliminal evaluative conditioning of illness with the self-schema causes quicker reaction times of words related to illness and self on a subsequent implicit association task (Greenwald & Farnham, 2000; Greenwald, McGhee, & Schwartz, 1998), indicating a stronger association between the self and illness (study 2).

**STUDY 1**

**Methods**

**Subjects**
Forty-two students from Leiden University participated in the present study. Participants received either course credits or five Euros for participating. This study was approved by the Ethics Committee of the Leiden University Institute of Psychological Research. Subjects were required to meet the following criteria: no medical disease,
Can Illness Memory be Activated by Subliminal Stimulation?

no chronic pain, no feelings of anxiety or depression, Dutch native language and no dyslexia.

**Materials**

**Questionnaires**

*Demographics and bio-behavioral variables.* We measured only gender, age, Body Mass Index (BMI), ethnicity, physical activities, usage of sleeping medication, pain killers or tranquilizers in the last 30 days, number of doctor visits in the last 6 months, and habits in smoking, coffee and alcohol drinking, drug use, medication use, illnesses, history of and current psychological problems.

**Experimental manipulation: subliminal priming task**

*Prime words.* Participants were randomly assigned to two different conditions, with prime words describing either (a) Health Complaints (HC), to activate an illness-related schema, or a control category: (b) neutral (NEU) words. Appendix A shows the prime words that were used in the current study. These words were also used in our previous study (Meerman et al., 2012). The categories contained 10 words and did not differ in number of syllables, length and frequency in the Dutch language. In every prime condition the 10 prime words were shown randomly 10 times, thus a total of 100 trials.

*Priming task.* The priming task was exactly the same as in our previous study (Meerman et al., 2012). The priming task was performed immediately before the lexical decision task. The priming manipulation was a variation of a common paradigm in which participants judge as quickly and accurately as possible whether briefly flashed letter strings appear on the right or left side of a computer monitor (Lowery et al., 2007). The present subliminal priming task consisted of a simple computer task presented to the participants as a reaction time task. For each trial of the task, a fixation cross with a random duration of 500-1000 ms, appeared in the center of the screen. Students were then exposed to the prime word (33 ms), and immediately after a string of XXX’s that served as a backward mask for the prime word. The prime word and mask appeared on either the right or left side of the screen, in the parafoveal region [at a 2 degree visual angle (Bargh & Chartrand, 2000)]. Participants indicated with the arrow keys what the position was of the XXX’s. Each trial was separated by a 500 ms interval in which the screen was blank. Stimuli were presented on a personal computer using the E-Prime 2.0 software (Psychology Software Tools, Pittsburgh, PA).

**Lexical decision task (LDT)**

The LDT (Meyer & Schvaneveldt, 1971) took place after participants were exposed to all the subliminal primes. Participants were told to identify, as quickly as possible, whether or not each character string is an actual Dutch word by pressing the arrow keys. Prior to the task, participants had ten practice trials (five words and five
non-words), in which all word stimuli were neutral. Subsequently, 28 different words and 28 non-words were randomly shown. The non-words were neutral words of which several letters were mixed up. The words consisted of seven illness words (e.g. ‘infection’, ‘coughing’), seven negative valence words (‘coward’, ‘vulgar’) and 14 neutral words (e.g. ‘art’, ‘child’). The words were matched on syllable, length and frequency. The onset of each trial was marked by a cross (+), which served as a fixation point. After 500 ms latency, the fixation point was replaced by a character string. The stimulus item disappeared after the participant responds.

Neutralizing priming task
For ethical reasons, the last task of the experiment contains a subliminal priming task with originally neutral prime words. This priming was done to avoid a long-term impact of the subliminal priming task with illness related words.

Awareness checks
To see if participants during the experiment were aware of the fact that they were subliminally primed, two different methods were used to check whether participants were able to detect prime words. After participants were primed and had done the LDT, they had to fill in a questionnaire with increasingly specific questions about the research purpose and suspicions. The questionnaire contained the following questions: ‘What do you think what the purpose was of this study?’ ‘Have you noticed something special in the computer tasks?’ ‘Do you think something has influenced your performance on the computer tasks?’ When the answers of the participants do not contain information about subliminal priming it can be assumed that the participants were not aware of the fact that they were subliminally primed. After this questionnaire the participant is explained that he/she is subliminally primed and that in the next computer task the same is going to happen. The participant is told that words are being represented and that he/she must try to guess what they are. If the participant is not able to guess any of the words, it is safe to say that the subliminal presentation has been achieved (Bargh & Chartrand, 2000).

Procedure
Participants were recruited personally by the researcher (E.E.M.) at the Leiden University. Before they actually participated in the study they were informed that the experiment consisted of different computer tasks, but they were not informed about the subliminal priming. After the introduction and screening, participants signed an informed consent. This informed the student that the purpose of the study is to get information about study skills (which served as a cover story) and reaction times. Participants were tested by an experimenter who was kept blind about the random assignment of the participants.

The participants completed four different computer tasks. The first computer task consisted of different questionnaires. The second computer task consisted of a ques-
questionnaire about study skills (cover story), followed by the subliminal priming task. The third computer task consisted of the LDT were participants had to decide as quickly as possible if it was an existing word or a nonsense word. The participants then completed the awareness checks, followed by the neutralizing priming task. After the experiment, participants were informed about the subliminal priming tasks and the true purpose of the study and received money or credits for participating in the experiment.

**Data analyses**

We used a repeated measures ANOVA with priming condition as the between-subjects factors (neutral, and illness) as the independent variables. The LDT reaction time measures for the illness words and for the negative control words were the dependent variables. We report the two-tailed $p$ value.

**Results**

Participants that were excluded were: with disease ($n = 3$), medication use ($n = 3$), used alcohol on day of experiment ($n = 1$). A total of 36 participants remained for the analyses. Reaction times of correct answers to the illness words and negative control words were analyzed. Data was checked for outliers (also within subject), homogeneity of variance and normality.

Participants reacted in general quicker on the illness related words ($M_{RT} = 606.00, SE = 15.06$) compared to the other negative control words ($M_{RT} = 694.16, SE = 22.81$), $F_{(1,33)} = 21.951, p = .000, \mu^2 = .399$ (see Figure 5-1). However, participants in the illness priming condition did not significantly react quicker to the illness words ($M_{RT} = 592.86, SE = 21.61$) compared to the negative control words ($M_{RT} = 619.13, SE = 21.00$), $F_{(1,33)} = .151, p = .701, \mu^2 = .005$. In addition, the illness priming did not influence the reaction times in general, $F_{(1,33)} = .989, p = .327, \mu^2 = .029$. 
Several of the demographic variables were associated with reaction times (RTs) in the LDT. However, even adjusting for these covariates, still no effect of priming was found on the RT’s, $F_{(1,31)} = .489, p = .489, \eta^2_p = .016$.

**Discussion**

The result of this part of our study do not yield support for our hypothesis that subliminal priming with illness words causes a significant quicker reaction time for illness words on a subsequent lexical decision task. This seems to indicate that the subliminal priming paradigm used in this and our previous studies was not effective in activating illness-related cognitive memory networks, at least not for the time frame used in this study (that is, several minutes) and our earlier studies.

**STUDY 2**

**Methods**

**Subjects**

Twenty-eight healthy students from the Leiden University participated in this study in return for either course credits or a small fee (five euros). Participants criteria were: be a student, at least 16 years old, native language Dutch, no medical illness, anxiety or depression. The following requirements were added to have the same conditions as to our previous study: no coffee or painkillers intake on the day of the experiment, and no smoking one hour before participation (Meerman et al., 2013).
Can Illness Memory be Activated by Subliminal Stimulation?

Materials

Questionnaires

Demographics and bio-behavioral variables. The same variables were measured as in study 1.

Experimental manipulation: Subliminal evaluative conditioning (SEC) task

We used the exact same task as our previous SEC study (Meerman et al., 2013). In the present study the subliminal evaluative conditioning consists of a simple computer task during which words were shown for a short duration (33 ms), followed by a ‘mask’ to abolish any afterimage. For each trial of the task, a row of Xs, with a random duration of 500 ms, appeared in the center of the screen. Because in our previous study (Meerman et al., 2013) some of the primes were shown for 33 ms and some were shown for 17 ms, in this study we made sure that all primes were shown for 33 ms. Participants were subliminally exposed to either a self-referring word “I” or a nonself-referring word “X” paired with illness words. Illness words were similar to the words in Study 1 and our previous studies (Appendix A). A string of random letters served as a backward mask for the prime words, and the participants were asked to decide as quickly as possible whether the letter string started with a vowel or consonant. The trials were presented in random order, the ten prime word pairings were shown randomly ten times, thus a total of 100 trials. The prime words and masks appeared in black in the center of the white screen. Each trial was separated by a 1000 ms interval in which the screen was blank. Participants were randomly assigned over the two different conditions (I+illness or X+illness). Stimuli were presented on a personal computer using the E-Prime 2.0 software (Psychology Software Tools, Pittsburgh, PA).

Implicit Association task (IAT)

In the implicit association task the participants were asked to sort words according to their category. The categories were either self vs. others, or healthy vs. sick. The target labels were ‘self’ and ‘other’, and the attribute labels were “healthy” and “sick”. Each category consisted of five stimuli (see Appendix B). Words appeared in random order in the middle of a computer screen and participants were instructed to sort them with a left response or right response key (Greenwald, Nosek, & Banaji, 2003; Nosek, Greenwald, & Banaji, 2005). In the instructions participants were told that the words only belonged to one category. Participants were also told they had to work as quickly and as accurately as possible and if they were too slow or made too many mistakes, it would result in non-interpretable scores. Participants were instructed to keep their fingers on the response keys, in order to react as quickly as possible. In addition, after each block they received feedback whether their average reaction speed was fast enough (below 5000 ms), or if they had to increase their speed. A fixation cross (+) appeared in the middle of the screen for 150 ms. The words were shown either in white or green, corresponding to the color that the associated label
was shown in. The stimulus word remained on the screen until a categorization had been made. If the participants made a wrong response a red X would appear, and the participants had to make the correct response in order to continue. Trials were separated by blank screens of 150 ms. The IAT procedure uses five blocks, and in each block the stimuli are shown in random order. First, participants discriminate between self (left) and other (right) with each item shown twice and in random order, thus in total twenty trials (block 1). Then participants were asked to discriminate between sick (left) and (health), also in twenty random trials (block 2). In blocks 3 and 4, participants were shown the combined two categories. Block 3 consisted of twenty practice trials and Block 4 consisted of forty critical trials. In block 5 participants were asked to discriminate again between health (left) and sick (right), but this time the categories switched sides (20 trials). In block 6 and 7, participants were shown the combined two categories again, with the self and health on the left, and other and sick on the right. Block 6 were 20 practice trials and block 7 were 40 critical trials. Category labels were displayed on the left and right sides of the window (and remained there during the complete block). Half of the participants followed the specified order described above (block 1 through block 7). The other half of the participants started with block 1, then block 5 through 7, followed by block 2 through 4. Thus, they first started with the self and healthy on the left side, and later switched to self and sick on the left side.

Positive evaluative conditioning task
This task was used, out of ethical considerations, at the end of the procedure to cancel out any possible negative effects of the first evaluative conditioning task, in which the self was paired with health complaints. In this task only the word “I” was paired with positive health words.

Procedure
Participants read the information sheet and began with the questionnaires, followed by a ten minute questionnaire about their study skills, to mask the goal of the experiment. Next, they moved on to the subliminal evaluative conditioning task. During the subliminal evaluative conditioning task, participants were asked to react as quickly as possible to the question whether a string of random letters starts with a vowel or not (the backward mask). The IAT began immediately after the conditioning task. The participants finished with the positive subliminal evaluative conditioning task where “I” was paired with good health words like vital, healthy and fit. In the end, the true nature of the experiment was revealed through a debriefing.

Results
Participants that were excluded were: with disease (n = 1), computer crashed during IAT (n = 1). A total of 26 participants remained for the analyses, with 14 participants in the “I”-illness group and 12 participants in the “X”-illness group. We used the im-
Can Illness Memory be Activated by Subliminal Stimulation?

proved scoring algorithm of the D-measure as proposed by Greenwald et al., (2003) that uses the reaction times of the practice blocks 3 and 6 as well to analyze the IAT data. We used the D1 measure in which trials with reaction times above 10,000 ms are discarded. This D measure also uses the reaction times of erroneous responses by adding the reaction time of the duration of correcting the response to the duration of the initial erroneous response (Greenwald et al., 2003; Nosek et al., 2005). The D-measure divides the difference between average reaction times between two blocks by the standard deviation of all the reaction times in the two test blocks and therefore adjusts for differences between means because of underlying variability (Greenwald et al., 2003). Data was checked for outliers (also within subject), homogeneity of variance and normality.

The average of the D1-measure over the whole group was negative, which means that most participants seemed to have stronger associations of the self with healthy words compared to sickness related words (M = -.39, SE = .06). However, no significant difference was found between the “I” + illness group (M = -.43, SE = .08) and the “X” + illness group (M = -.35, SE = .09), F(1,24) = .52, p = .48, μD = .02. As with study 1, we used stepwise regression analyses to select the two strongest predictors for the d’-measure to examine the difference of the adjusted means for the two groups. However, the adjusted means between the groups did not differ, F(1,22) = 1.11, p = .30, μD = .05.

Discussion

The results of the second study did not support our second hypothesis that subliminal evaluative conditioning of illness with self-referent stimuli causes quicker reaction times of words related to illness and self on a subsequent implicit association task. This means that the subliminal evaluative conditioning technique used in our previous study did not create a stronger association between the self and illness.

General Discussion

The current studies were carried out to test the validity of two priming methods to temporarily increase illness memory. These tests are important for at least two reasons. First, the outcome will help to determine whether our previous negative findings with these methods (Meerman et al., 2013) represent a true disconfirmation of the hypotheses that activated illness memory causes increased symptom reporting (Brosschot, 2002; Brown, 2004), or method failure instead. Second, the outcome can potentially have consequences for understanding prolonged behavioral effects of subliminal priming that have repeatedly been found in other areas, especially in social psychology (for example, Refs. Kiefer, 2002; Levy, 1996; Pierce & Lydon, 1998; Lowery et al., 2007). Thus, we examined whether subliminal priming with illness stimuli did indeed activate illness memory, using a lexical decision task (LDT). We also examined whether subliminal evaluative conditioning technique in which ‘self’ is associated with ‘illness’ actually showed the supposed manipulation effect, which is increased implicit
association between self-schema and illness-related schema using an implicit association task (IAT). The results of the first study showed that the subliminal priming technique did not result in significantly quicker responses on illness words on a LDT compared to neutral words. The second study showed that the subliminal evaluative conditioning technique did also not result in quicker reaction times for the word “I” in combination with illness related words in an IAT. Given that these tasks are standard tasks within psychological research to examine the cognitive phenomena in question; these findings lead us to conclude that these priming methods are unfit to increase illness memory or increase associations between the self and illness. This implies that our previous studies failed to find effects of these methods on symptom reporting (i.e. pain tolerance) do not falsify the hypothesis that activated illness memory can increase symptom reporting, since we it is unlikely that we have actually activated illness memory in the first place.

We set out using these widely used methods in our previous studies trusting that they would induce the supposed memory activation. That they do not do so is surprising given their broad use in psychology and the vast range of behavioral findings. This brings us to the second implication of our finding. Does the failure of these methods mean that the broadly published behavioral findings are not caused by activated memory? Is it possible that they lead to triggering behavioral programs on a lower, motoric level without having substantial effect on memory? It is perhaps too early to ask these questions. First, it is theoretically possible, though not likely, that the supposed memory effects may still be found for other content than illness related content. Second, it should be noted that this study was conducted in a small group sample. Nonetheless, these priming techniques should have a large and stable effect, and as mentioned, many studies have used the same techniques for manipulating various schemata and affect. Thus, again, the conclusion seems warranted that the use of the priming techniques as used in our studies as ell s these other studies was not, contrary to our expectations, manipulating illness-related schemata at all, at least not during the time frame in which the found behavioral effects are usually found.

In conclusion, our finding that subliminal priming and evaluative conditioning concerning illness information did not activate illness memory may reflect a more general failure to support priming as a basic phenomenon. We would like to stress that future studies using a priming technique, whether it is subliminal or supraliminal priming, should always include a manipulation check to ensure that the technique indeed resulted in the expected manipulation of memory.

Finally, and in a way sadly, the results of this current study imply that we have not yet adequately tested yet whether the hypothesis that illness-related cognitive memory network causes increased symptom reporting because the subliminal priming techniques did not temporarily activate the illness-related schemata. We derive some solace though from the fact that our studies contributes at least to a better understanding of the phenomena priming.
Appendix A. Prime words used in current study. English words are translated from Dutch prime words.

<table>
<thead>
<tr>
<th>Neutral</th>
<th>Health Complaints</th>
</tr>
</thead>
<tbody>
<tr>
<td>“bear”</td>
<td>“allergy”</td>
</tr>
<tr>
<td>“butterfly”</td>
<td>“asthma”</td>
</tr>
<tr>
<td>“seal”</td>
<td>“vomiting”</td>
</tr>
<tr>
<td>“giraffe”</td>
<td>“diarrhea”</td>
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<td>“heartburn”</td>
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<tr>
<td>“chimpanzee”</td>
<td>“inflammation”</td>
</tr>
<tr>
<td>“squirrel”</td>
<td>“wound”</td>
</tr>
</tbody>
</table>

Appendix B: Words used in the IAT

Self: eigen (“self”), ik (“I”), mezelf (“myself”), mijn (“mine”), zelf (“self”).
Other: ander (“other”), hun (“them”), jullie (“you”), zij (“they”), zijzelf (“themselves”).
Healthy: fit (“physically fit”), vitaal (“vigorous”), blakend (“healthy”), energiek (“energetic”), sterk (“strong”).
Sick: onwel (“unwell”), beroerd (“nauseous”), kwaal (“ailment”), aandoening (“illness”), pijn (“pain”).