

Abstract

This study investigated transfer of thought suppression functions via ‘same’ and ‘opposite’ relations. In Experiment 1 participants were trained and tested for two five-member relational networks involving same and opposite relations. They then had to suppress a target word from one of the two networks, while words appeared individually onscreen including the target, and words either in the same (target) or a different (nontarget) network. They could remove any word by pressing the spacebar. Findings showed more frequent and faster removal of the target than other words and of words in the target network than other words. Experiment 2, which involved predominantly ‘opposite’ relations, produced a similar but weaker pattern. Experiment 3 replicated the pattern seen in Experiment 2, while showing that the relations designated as opposite produced a more conventional transformation of functions in a context other than thought suppression.

Thought suppression is a relatively common technique for dealing with unwanted thoughts (Rachman & De Silva, 1978); however, attempts at thought suppression often prove futile and even counterproductive, leading the individual to be more aware of the unwanted thought than prior to the suppression attempt (Wegner, Carter, Schneider & White, 1987). Wegner (1989) proposed the 'Environmental Cueing Hypothesis' (ECH) to explain this. According to the ECH, suppression involves two cognitive processes, namely 'automatic target search' and 'controlled distractor search'. The former is an unconscious and automatic process that searches to see whether the unconscious thought is present, while the latter is a conscious and deliberate process that seeks out distracting information with which to replace the unwanted thought. Due to the unconscious nature of the former, evidence of the unwanted thought is found more quickly than the consciously controlled distractor search can generate distracters. Hence, it is claimed, associations are made between the unwanted thought and the generated distracters, which leads to heightened accessibility of the unwanted thought.

Wegner and colleagues have contributed a useful methodological approach and important empirical data on the phenomenon of thought suppression (e.g., Najmi & Wegner, 2008). However, their theoretical approach is classically cognitivist in orientation. The theoretical basis of the current research, however, is contextual behavioral science and more specifically relational frame theory (RFT; Hayes, Barnes-Holmes & Roche, 2001) and thus before explaining how our empirical investigations extend from those of Wegner et al., we will first provide a brief description of thought suppression from the current perspective.

From a contextual behavioral point of view, 'thinking' is a type of verbal behavior. RFT sees the latter in turn as a form of generalized relational responding referred to as relational framing (see Dymond & Roche, 2013 for recent empirical data supporting this approach). From this perspective, relational framing, including thinking, is part of an individual's learned behavioral repertoire and as with other forms of behavior, it can itself

become a stimulus that evokes or elicits further responding, including (very often) further relational framing. Thought suppression is one such pattern of behavior that occurs in response to one's own previous framing. It can be conceptualised specifically as coming under the influence of a relational network or 'rule' of the form 'Do not think of X' (see Wilson, Hayes, Gregg & Zettle, 2001). In a naturalistic context, X might be the name of something unpleasant or aversive. In any event, however, this particular type of rule is unusual. From an RFT point of view, relational framing in accordance with a rule typically transforms the functions of the environment for a verbal listener such that they respond to it in particular ways as specified by the rule. For example, the rule "Stay on the path" may strengthen the approach functions of the path referred to in the rule. However, in the case of the rule 'Do not think of X', the relational behavior specified is incompatible with the relational behavior involved in understanding the rule in the first place. More specifically, understanding the rule involves thinking of (framing with respect to) X; however, this is behavior that the rule itself proscribes. Hence, following the rule is impossible.

Nevertheless, behavior can still be affected by this rule because the listener might derive relations based on it such as 'Well, if I'm supposed to not think of X, then I should try to think of something other than X'. Wegner's ECH theory provides a cognitive interpretation of the psychological processes that ensue. From the current perspective, following this rule will likely involve coming under the stimulus control of an object or event that is in a relation of difference from or opposition to the target (to-be-avoided) stimulus for the rule follower. That might happen through physical orientation to objects / events that are framed as being in such relations in the immediate environment, or by responding covertly to stimuli or events that are thus framed that are not immediately present.

This 'distraction' strategy may work to some extent if after engaging in it for a period of time the person is no longer relationally framing with respect to the 'to-be-avoided'

stimulus; if, in other words, they are no longer ‘conscious’ of the target. However, to check if this is indeed happening and they are thus following the rule, they must periodically compare the behavior specified by the rule (i.e., ‘Do not think of X’) with their own recent behavior. Doing this involves relationally framing in accordance with the rule again, which means framing with respect to (and thus becoming conscious of) the target again and thus immediately breaking the rule again. Thus, checking how successful their thought suppression attempt has been necessitates breaking the rule. In an important sense then, true thought suppression is self-contradictory and impossible.

Despite this, there is a sense in which attempted suppression may be evaluated by the person engaging in this behavior as successful to at least some extent and to be more successful on some occasions than on others. Length of time during which a person has not been relationally framing with respect to a suppression target may be one important variable as regards the evaluation of success. If the person does not frame with respect to the ‘to-be-avoided’ stimulus for what they discriminate as a sufficiently long time, then when they next compare their behavior with the rule they may judge the former as relatively successful with respect to the latter. Conversely, the shorter the period during which they have not been framing the target, the less likely the person may be to say that they have been successfully suppressing. Certain stimuli, including environmental stimuli as well as the person’s own relational framing, may make the ‘period of successful suppression’ shorter than it otherwise might be. One subcategory of such stimuli, identified by Wegner, that might do this, could be stimuli framed as distractors. As discussed above, these stimuli might have been originally framed as being in a relation of difference or opposition from the to-be-avoided stimulus. However, despite the nature of the relations involved, the very fact that they are relationally framed with the stimulus means that they may now be more likely to evoke the stimulus (just as ‘white’ might evoke ‘black’, for example). RFT would suggest that the more frequently

that particular distractors are involved in suppression behavior, the stronger the relation between them and the to-be-avoided stimulus and the more likely those distractors will be to evoke the to-be-avoided stimulus. In addition, the greater the number of different distractors involved, the greater the chances of evocation of the 'to-be-avoided' stimulus also.

So far the contextual behavioral RFT explanation can be seen as simply paralleling the cognitivist explanation of Wegner and colleagues given earlier for why suppression is so often unsuccessful. However, the former approach also affords an important extension of this conceptualization. According to RFT, the learned human capacity to relationally frame stimuli allows humans to demonstrate what is referred to as derived relational responding. Furthermore, evidence provided by Hooper, Saunders and McHugh (2010) indicates that this phenomenon may play a critically important role in making thought suppression unsuccessful and thus current theories of the latter such as Wegner's ECH need to take it into account.

The most well-known example of derived relational responding is stimulus equivalence. This is an empirical effect in which an experimental participant is taught a series of interrelated conditional discriminations between arbitrary stimuli and subsequently derives an equivalence or sameness relation between the stimuli involved. For example, when a verbally able human is taught to select stimulus B in the presence of stimulus A and to select stimulus C in the presence of B, then they are likely to derive a relation of sameness between A, B and C and thus if tested will show a number of additional untrained performances on this basis (e.g., selection of A in the presence of B and B in the presence of C [symmetry]; selection of C in the presence of A [transitivity]; and A in the presence of C [combined symmetry and transitivity]). In addition, equivalence is accompanied by a 'transfer of function' effect, whereby a psychological function trained to one member of an equivalence relation spontaneously transfers to the other members without additional training (Augustson & Dougher, 1997; Barnes, Browne, Smeets & Roche, 1995; Greenway, Dougher & Wulfert,

1996; Roche & Barnes, 1997). For example, in Augustson et al. (1997), participants trained to avoid a stimulus correlated with shock also showed avoidance of stimuli in derived equivalence relations with the conditioned stimulus.

Hooper et al. (2010) demonstrated how the phenomenon of transfer of function through derived equivalence relations could make thought suppression less successful (i.e., as per our discussion above, of relatively shorter duration). These authors referred to the phenomenon whereby certain stimuli could make thought suppression less successful as ‘interference’ with thought suppression. In addition, they argued that the process described by Wegner’s ECH (whereby a stimulus directly framed by the participant as a distractor could eventually result in less successful suppression) should be designated ‘direct’ interference, while the process of making suppression less successful based on derived relations should be designated ‘indirect’ interference. In this study, participants were first trained and tested for the derivation of three three-member equivalence relations. They were then instructed to suppress all thoughts of a particular target word that had appeared in one of the three derived equivalence relations. While trying to suppress the target word, they were given the option to remove words that appeared on a computer screen. These words included the to-be-suppressed target stimulus, as well as words that were directly trained to this stimulus (i.e., words whose selection in the presence of the target stimulus was reinforced) and words that were in derived relations with it. As in previous paradigms used by Wegner and colleagues, removal of a word was treated as indicating that that word interfered with thought suppression. Findings showed that, as expected based on previous empirical work, the participants removed the target word as well as words that were directly trained to this stimulus; however, in addition, they also removed words in derived relations with the target. In removing the target and words directly trained to it, participants showed direct thought

suppression interference. However, in removing words in derived relations with the target, they also showed indirect thought suppression interference via derived transfer of function.

Thus, Hooper et al. extended the research of Wegner and colleagues (e.g., 1991; 1992) by showing that derived equivalence responding might constitute a process whereby indirect thought suppression interference could occur. This was an important advance; however, according to RFT, humans demonstrate many patterns of derived relational responding in addition to equivalence. These include opposition, distinction, comparison and deixis, for example, and there is by now an appreciable quantity of empirical evidence for them (see Dymond & Roche, 2013). As such, it seems likely that promulgation of thought suppression through nonequivalence relations could also be possible.

A recent study by Dymond, Roche, Forsyth, Whelan and Rhoden (2007) provides an example of the empirical demonstration of derived relations other than equivalence. In this study, nonarbitrary relational training was first provided to establish arbitrary shapes as contextual cues for patterns of ‘same’ and ‘opposite’ relational responding. In the presence of one arbitrary shape (designated ‘same’), participants were trained to choose comparison stimuli physically identical to a sample (e.g., short line – short line) while in the presence of a second shape (designated ‘opposite’), they were trained to choose comparison stimuli as physically different from the sample as possible (e.g., short line – long line). Once thus established, the cues were then used to train patterns of same and opposite relations between arbitrary nonsense syllables. The following relations were trained up (the first [bracketed] letter in each trial-type indicates the contextual cue, the second indicates the sample while the third indicates the correct comparison): [S] A1-B1; [S] A1-C1; [O] A1-B2; [O] A1-C2. Then, once training had been completed, the following derived relations were tested: [S] B1-C1; [S] C1-B1; [S] B2-C2; [S] C2-B2; [O] B1-C2; [O] C2-B1; [O] B2-C1; [O] C1-B2. All of the participants showed predicted responding in accordance with derived same and opposite

relations. For example, having been trained that both C1 and B1 are the same as A1, participants derived that B1 and C1 are the same as each other. Furthermore, having been trained that C1 is the same as A1 and B2 is the opposite of A1, they derived that C1 and B2 are opposite. Finally, having been trained that both B2 and C2 are opposite of A1, they derived that they are the same as each other.

More importantly from the perspective of the current study, these researchers also demonstrated a transformation of functions in accordance with both same and opposite relations. ‘Transformation of functions’ is an RFT term used to refer to the acquisition by a stimulus of a novel psychological function or functions in the absence of direct training, based on the participation of that stimulus in derived relations. In the context of equivalence, the term ‘transfer of function’ is appropriate because the novel functions that are acquired by stimuli in derived equivalence relations with the originally trained stimulus are the same as the originally trained functions. However, in the context of multiple derived stimulus relations, including nonequivalence relations, the more generic term ‘transformation of functions’ is preferred because the functions that are acquired can differ from those originally trained, depending on the nature of the derived relations in question¹. For example, if a relation of opposition is derived between two stimuli A and B, and A has previously been trained to be discriminative for avoidance, then the functions of B may be transformed such that B becomes discriminative for approach.

Dymond et al. (2007) examined derived relations based behavioral change involving the same psychological function as in Augustson and Dougher (1997), namely a shock avoidance function. Just as in the latter study, participants in the former study were trained to

¹ In RFT, ‘transformation’ is a generic term that includes transfer, but to avoid ambiguity, in this article ‘transfer’ will refer to acquisition of the same function as the original stimulus, while ‘transformation’ will refer to acquisition of a changed function.

make an avoidance response in the presence of one particular stimulus (B1). However, whereas Augustson et al. (1997) showed transfer of avoidance functions in accordance with equivalence or sameness relations exclusively, Dymond et al. (2007) showed both transfer and transformation of avoidance via same and opposite relations, respectively. For example, all but one of the participants who showed conditioned avoidance with B1 also showed both transfer and transformation of C1 and C2 via sameness and opposition, respectively, so that C1 acquired an avoidance function while C2 acquired an approach function.

The purpose of this study was to extend Hooper et al. (2010) by assessing for transfer and transformation of thought suppression interference via same and opposite relations, respectively. In a context in which the psychological functions at issue are thought suppression interference functions, exploring transformation through relations of opposition is particularly interesting. First, opposition would seem relevant because when a person is trying to suppress a thought then one strategy may be to think of something that is the opposite of the to-be-suppressed stimulus along one or more pertinent dimensions. For example, if I am trying not to think of something sad or depressing then I may think instead of something that is the opposite in that it is typically happy or uplifting. However, doing this often fails, suggesting that stimuli in opposition relations might acquire functions of the to-be-suppressed stimulus. If the latter does occur then this would suggest that transfer rather than transformation of functions has occurred. Thus, a second reason that opposition relations seem particularly worthy of exploration in this context is the atypical pattern of change of functions that may result.

This study involved training and testing same and opposite relational networks using a similar procedure to that employed by Whelan, Cullinan, O'Donovan, and Valverde (2005), a previous RFT-based study that investigated priming effects in networks of same and opposite relations. In Experiment 1 of the current study, a nonarbitrary relational training and testing

procedure was first used to establish contextual cue functions in arbitrary shape stimuli. Next the contextual cues thus established were employed to train and test two separate arbitrary relational networks, both involving arbitrary nonsense syllables in both trained and derived same and opposite relations. Then, using a procedure similar to that employed in Hooper et al. (2010), participants were required to suppress a target word from one of the two relational networks. In the final phase of the procedure, participants were given the option to remove words that appear on a computer screen. These words included the to-be-suppressed target; words directly trained to it; words in derived same and opposite relations with it; and words from the other relational network (i.e., the one not including the target word). Direct and indirect (derived) thought suppression interference was measured by assessing both frequency and latency of word removal and comparisons across different functional categories of word were made in the case of both these variables. As in Hooper et al. (2010), latency of word removal was included as an alternative measure of responding that might yield additional information concerning response patterns. Though in Hooper et al. no detectable difference was seen between latency and frequency in terms of the broad pattern observed, the latter were analysing derived thought suppression in the context of equivalence only. In the context of the analysis of both 'same' and 'opposite' relations it is possible that latency might pick up on differences between the relations that frequency does not.

It was predicted that, as in similar previous RFT studies, there would be a change of stimulus functions via 'same' and 'opposite' relations. However, as indicated, the change of functions through opposition relations might be different (and more specifically, more similar to that seen for equivalence relations) in the context of thought suppression than in the context of other functions such as shock avoidance.

EXPERIMENT 1

Method

Participants

11 individuals participated in the study. Of these, 3 were female and 8 were male and their ages ranged from 22 to 30 years ($M = 25.3$). All participants were volunteers who were contacted through personal acquaintances and chosen on the basis that they had no previous experience or knowledge of derived relations.

Design

Both single subject and group analyses were conducted. For the latter, a within subjects design was employed with repeated measures taken on word relation type (target, taught same, derived same, derived opposite, nontarget network, nonnetwork, novel). The two dependent variables were frequency and latency of word removal.

Apparatus & Materials

Experiments were conducted in a small room in which participants sat at a table with a computer programmed in Visual Basic 6.0 that controlled all stimulus presentations and recorded all responses. Two arbitrary stimuli were established as contextual cues for Same (i.e., Ψ) and Opposite (i.e., X) respectively. The stimuli used in the relational networks and in the suppression phase in Experiment 1 and subsequent experiments are shown in Table 1. The alphanumeric labels in brackets beside the stimuli used during the training and testing of the relational networks are employed in this report for ease of communication. The participants never saw these labels.

Insert Table 1 about here

Procedure

Participants were exposed to the following five experimental phases (i) Same Opposite Nonarbitrary Relational Training and Testing; (ii) Same Opposite Arbitrary

Relational Training and Testing; (iii) Suppression Induction; (iv) Cognitive Load Induction; (v) Suppression Task.

(i) Establishing Same & Opposite Contextual Cues Via NonArbitrary Relations. At the start of the experiment, the participant was shown into the experimental room and was seated in front of the laptop computer. They were then exposed to the following instructions, which were presented across the middle of the computer screen:

During this phase of the experiment you will see a number of images on the screen.

Look at the image at the top of the screen, then look at the image in the middle of the screen, and finally look at the three images at the bottom of the screen on the left, middle, and right. Choose one of the three images at the bottom of the screen by selecting it with the mouse. You will have to learn the correct response by trial and error. Sometimes, you will be given feedback on your selection; however, at other times you will not receive feedback.

This phase involved nonarbitrary relational training and testing using a matching-to-sample procedure. On each trial, the arbitrary shape to be established as a contextual cue appeared first after 0.5 seconds in the top centre of the computer screen, then 0.5 seconds later the sample stimulus appeared in the middle of the screen and finally another 0.5 seconds later three comparison stimuli appeared in a quasirandom positional order of presentation along the bottom. Stimuli remained on the screen until the participant selected one of the comparisons using the mouse. During training, feedback appeared in the form of the textual stimuli “Correct” or “Wrong” being presented in inch high red letters in the centre of the screen for 1.5 s. During testing, no feedback was presented. An inter-trial interval of 2.5 s followed the feedback during training and the response during testing.

The sample and comparison stimuli in both training and testing were related to each other along a physical dimension and the correct answer depended on the contextual cue and

the nature of the physical relation. For example, in the case of one set of stimuli, the sample was either a short line or a long line and the comparison stimuli consisted of three lines; long, medium and short. If the contextual cue for same was presented then a correct response involved choosing the comparison that was the same length of line as the sample, while if the contextual cue for opposite was presented then a correct response involved choosing the short line if the sample was long and vice versa.

The following convention is used in describing match-to-sample probes, both non-arbitrary and arbitrary: the contextual cue is presented first, followed by the sample stimulus and then the three comparisons are listed in brackets with the reinforced comparison in italics. Using this convention, the trial types described in the last paragraph are as follows: SAME/Long line-[Short line-Medium line-*Long line*]; SAME/Short line [*Short line*-Medium line-Long line]; OPPOSITE/ Long line-[*Short line*-Medium line-*Long line*]; OPPOSITE/ Short line [*Short line*-Medium line-*Long line*]. This collection of trial types constitutes one problem set, referred to as Problem Set 1. There were four problem sets in total, each utilizing different stimuli and each consisting of four trial types analogous to those in the first set. The trial types for each problem set were presented in a quasirandom order in blocks of four trials with each trial-type presented once per block. During the first training phase participants were trained on alternate blocks of Problem Set 1 and Problem Set 2 trials with each block presented four times, making a total of 32 trials and they were required to respond correctly to each of the final 16 trials in order to reach the mastery criterion.

If a participant did not reach the mastery criterion then they were exposed to another 32 trial phase on Problem Sets 1 and 2. If they did reach the mastery criterion, however, then they were exposed to the first nonarbitrary relational testing phase. This was similar to the training phase in that it involved the presentation of alternating blocks of quasirandomly

ordered trial-types. However, during this phase there was no feedback and instead of Problem Sets 1 and 2 being presented, Problem Sets 3 and 4 were employed.

If participants failed nonarbitrary relational testing with Problem Sets 3 and 4 then it was intended that they would be exposed to further training and testing identically structured to that just used but with novel problem sets (5 and 6 for training and 7 and 8 for testing). However, all participants passed nonarbitrary relational testing on their first exposure.

(ii) Same & Opposite Arbitrary Relational Training and Testing. Nonarbitrary relational training and testing was immediately followed by arbitrary relational training and testing. This was designed to use the contextual cues established in the previous phase to train and test two separate networks of arbitrary same and opposite relations using mostly nonsense words as stimuli but also including two real words, one in the experimental network and one in the control network.

At the start of the training section of this phase, participants were provided with the following instructions:

During this phase of the experiment you will see a number of words and images on the screen. Look at the image at the top of the screen, then look at the word in the middle of the screen, and finally look at the three words at the bottom of the screen on the left, middle, and right. Choose one of the three words at the bottom of the screen by selecting it with the mouse. You will have to learn the correct response by trial and error. You will be given feedback on your selection; however, during some parts of the experiment you may not receive any feedback.

A matching-to-sample procedure similar to that used in the nonarbitrary phase was employed. Hence, on each trial, the contextual cue appeared first after 0.5 seconds in the top centre of the computer screen, then 0.5 seconds later the sample stimulus appeared in the middle of the screen and finally another 0.5 seconds later three comparison stimuli appeared

in a quasirandom positional order of presentation along the bottom. Stimuli remained on the screen until the participant selected one of the comparisons using the mouse. During training, feedback appeared in the form of the textual stimuli “Correct” or “Wrong” being presented in inch high red letters in the centre of the screen for 1.5 s. During testing, no feedback was presented. An inter-trial interval of 2.5 s followed the feedback during training and the response during testing.

This phase involved two separate stages. Both stages involved training and testing two separate relational networks including a target network that contained the word (Bear) to be used as the to-be-suppressed (target) word in the latter phase of the experiment, and a nontarget network (see Figure 1 for the target and nontarget networks and Table 1 for the actual stimuli used). However Stage 1 focused primarily on the target network while Stage 2 focused primarily on the nontarget network.

Insert Figure 1 about here

Stage 1. Training for this stage involved the following eight trial-types: SAME / A1-[B1-B2-N1]; SAME / A1-[C1-C2-N2]; OPPOSITE / A1-[B1-B2-N1]; OPPOSITE / A1-[C1-C2-N2]; SAME / X3-[Y3-B1-N3]; SAME / X3-[Z3-C1-N4]; OPPOSITE / X3-[Y4-B2-N3]; OPPOSITE / X3-[Z4-C2-N4]. The latter 4 tasks involved stimuli from the nontarget network but they functioned primarily to support the training of the target network by ensuring that participants were not simply being taught to always pick B1 and C1 in the presence of SAME and always pick B2 and C2 in the presence of OPPOSITE, which would be inappropriate stimulus control. Training was presented in quasirandom blocks of eight trials in which each of the above trial types was presented once and that were repeated until the participant had

responded correctly to forty consecutively correct trials. Once the criterion had been met, the testing section began.

The aim of arbitrary relational testing was to assess for responding in accordance with the derived relations of SAME and OPPOSITE in each of the two networks, as per Figure 1. In the target network, the trial types were as follows (the correct choice is in italics): SAME / B1-[C1-C2-N1]; SAME / B2-[C1-C2-N2]; OPPOSITE / B1-[C1-C2-N1]; OPPOSITE / B2-[C1-C2-N2]. Given the relations that were trained, participants were expected to make the following selections: (i) C1 with B1 in the presence of the SAME cue (because both are the same as A1); (ii) C2 with B2 in the presence of SAME (because both are opposite to A1 and thus the same as each other); (iii) C2 with B1 in the presence of OPPOSITE (because B1 is the same as A1 and C2 is opposite to A1 thus B1 is opposite to C2); (iv) C1 with B2 in the presence of OPPOSITE (because B2 is the opposite to A1 and C1 is the same as A1 so therefore B2 and C1 are opposites). Testing involved the quasirandom presentation of the 4 trials types 8 times each in a block of 32 trials. The mastery criterion for passing the testing was 31 / 32 correct responses. If the participant passed then they were exposed to Stage 2 of training and testing (i.e., focusing on the nontarget network). If they failed then they were re-exposed to Stage 1 training and testing up to a maximum of four times, after which, if they had still not passed, they would be excused from further participation in the experiment.

Stage 2. Training for this stage involved the following eight trial-types: SAME / X3-[Y3-Y4-N3]; SAME / X3-[Z3-Z4-N4]; OPPOSITE / X3-[Y3-Y4-N3]; OPPOSITE / X3-[Z3-Z4-N4]; SAME / A1-[B1-Y3-N1]; SAME / A1-[C1-Z3-N2]; OPPOSITE / A1-[B2-Y4-N1]; OPPOSITE / A1-[C2-Z4-N2]. The latter 4 tasks involved stimuli from the other (target) relational network but they functioned primarily to support the training of the nontarget network by ensuring that participants were not simply being taught to always pick Y3 and Z3 in the presence of SAME and always pick Y4 and Z4 in the presence of OPPOSITE. Training

was presented in quasirandom blocks of eight trials in which each of the above trial types was presented once and that were repeated until the participant had responded correctly to forty consecutively correct trials. Once the criterion had been met, the testing section began.

In the nontarget network, the trial types were as follows (the correct choice is in italics): SAME / Y3-[Z3-Z4-N1]; SAME / Y4-[Z3-Z4-N2]; OPPOSITE / Y3-[Z3-Z4-N1]; OPPOSITE / Y4-[Z3-Z4-N2]. Given the relations that were trained, participants were expected to make the following selections: (i) Z3 with Y3 in the presence of the SAME cue (because both are the same as X3); (ii) Z4 with Y4 in the presence of SAME (because both are opposite to X3 and thus the same as each other); (iii) Z4 with Y3 in the presence of OPPOSITE (because Y3 is the same as X3 and Z4 is opposite to X3 thus Y3 is opposite to Z4); (iv) Z3 with Y4 in the presence of OPPOSITE (because Y4 is the opposite to X3 and Z3 is the same as X3 so therefore Y4 and Z3 are opposites). Testing involved the quasirandom presentation of the 4 trial types 8 times each in a block of 32 trials. The mastery criterion for passing the testing was 31 / 32 correct responses. If the participant passed then they were exposed to the next session of training and testing and if they failed then they were re-exposed to training and testing for the nontarget network up to a maximum of four times, after which, if they had still not passed, they would be excused from further participation in the experiment.

If a participant passed training and testing in both the target and nontarget networks then they graduated to the third phase of the experiment, the suppression induction phase.

(iii) Suppression Induction. The aim of this phase was to familiarise participants with the suppression task. It began with the participant being instructed to suppress all thoughts of the word 'Bear' for a five minute period. The following onscreen instruction was presented:

“For the next phase of the experiment, try not to think of the word ‘Bear’. If you have any questions, please ask the experimenter.”

Once the participant had read this instruction, then, if they had a question for the experimenter, then he would repeat the relevant instruction. After this, or if they had no questions, they could continue by clicking a button that produced the next instruction:

“For the next five minutes you have to press the spacebar every time you think of the word ‘Bear’. Press the ‘Continue’ button when you are ready to begin”.

Once the participant had pressed the ‘Continue’ button, the screen went blank and it remained blank for five minutes. During this time, the task of the participant was to suppress thoughts of the word ‘Bear’ and to press the computer spacebar every time they thought of the word.

(iv) Cognitive Load Induction. The purpose of this brief penultimate stage of the experiment, which followed immediately after the suppression induction stage, was to provide the participant with a ‘cognitive load’ that would be present during the suppression task, because evidence suggests that having a relatively high cognitive load increases the rebound effects of attempted thought suppression (Wegner & Erber, 1992). Participants saw the following instruction across the middle of the computer screen:

“Thank you for your participation so far. Next, you are about to see a 9-digit number. Your job is to commit this number to memory over the next 25 seconds and write it down at the end of the experiment. Press the ‘Continue’ button to see the number.”

When participants pressed the continue button, they saw a nine digit number, which remained on the screen for twenty five seconds.

(v) Suppression Task. This final stage began immediately after the end of the cognitive load induction. The participant was presented with the following instructions:

“For the next part of the experiment you are asked to continue to suppress the thought you have been asked to suppress whilst attending to the computer screen. It is important that you continue to suppress this thought as you did in the previous part of the study. Once the program has started, words will appear every ten seconds in the

centre of the screen. However, you are in control of the program, so, if you are not happy with a word being on the screen then you can remove it by pressing the spacebar. If you choose to remove a word the screen will stay blank for the remainder of the 10 seconds at which point the next word will appear. Remember that it is vitally important that you attend to the screen but continue to suppress the thought. When you are ready, please press 'Continue'.”

During this phase, a set of 28 words in quasi-random order was presented on the computer screen four times in succession, making a total of 112 word presentations. The set of words included the words, both nonsense and real, that were in the two trained and tested relational networks as well as other, previously unseen words (see Table 1). Each word was presented onscreen for 10 seconds. Removal of a word meant that the screen remained blank for the remainder of the 10 seconds before the next word was presented. Because each word was presented four times; participants had four opportunities to remove each word. The computer program recorded how many times each word was removed, and, in the case that a word was removed, the latency from the stimulus-onset to the removal of the word. After completing the suppression task, participants were thanked and fully debriefed.

Experiment 1: Results & Discussion

All eleven participants passed nonarbitrary relational training and testing on their first attempt. One person (male, age 22) failed to pass arbitrary relational testing for the target relational network and was excused. The remaining ten completed two sessions of arbitrary relational training and testing (i.e., one for the target network and one for the nontarget network), with none taking more than three cycles of training and testing to reach criterion in either session. All ten showed space bar presses ($M = 30.7$) during the 5 minute suppression induction phase and at the end of the experiment, all correctly reproduced the 9-digit number from the cognitive load phase, showing that they had followed the instructions for the latter.

Suppression Task Word Removal Frequency

Figure 2 shows the mean frequency of removals for seven categories of word in the suppression task (separate analyses suggested no significant differences in responding to B2 and C2, the stimuli in derived opposite relations with the target and thus their data were combined): (a) the target (mean = 4.00, SD = 0.00); (b) the trained SAME word (mean = 3.1, SD = 1.52); (c) the derived SAME word (mean = 3.00, SD = 1.33); (d) the mean of the two derived OPPOSITE words (mean = 2.7, SD = 1.57); (e) the mean for nontarget network words (mean = 1.32, SD = 0.96); (f) the mean for nonnetwork words, which appeared in training but were not part of either network (mean = 0.825, SD = 1.33); and (g) the mean for novel words, which appeared only in the suppression task (mean = 0.67, SD = 1.19).

Insert Figure 2 about here

A one way repeated measures ANOVA revealed a significant effect of word category ($F [6, 54] = 11.851, p < .001, \eta_p^2 = .568$). The results of pairwise comparison t-tests (LSD) are shown in Table 2. The mean number of responses to the target was significantly higher than that to all other categories except for the word in a trained relation of sameness with it, while the mean number of responses to all categories in the target network was significantly higher than that to all categories outside the target network (i.e., nontarget network, nonnetwork and novel). This suggests that participants were significantly more likely to remove the target and words related to it, than words in an alternative relational network, or words that were unrelated or novel.

Insert Table 2 about here

These group level results reveal a pattern in which participants responded strongly to avoid the to-be-suppressed word and were also more likely on average to remove words related to that word, whether in relations of sameness or of opposition, than to remove words from outside that relational network. Most relevant for this study, there was no significant difference between mean number of responses to derived OPPOSITE (B2 and C2) words and the mean number of responses to the derived SAME (C1) word, though the mean number of responses to each of these was significantly higher than to nontarget network, nonnetwork, and novel words. This suggests that the thought suppression functions of the target B1 was transferred to the same extent across both SAME and OPPOSITE derived relations.

Insert Figure 3 about here

Figure 3 shows frequency of removal for each of the seven categories of word in the target network (i.e., target, trained same, derived same, derived opposite, nontarget network, nonnetwork and novel) for each individual participant. As may be seen, all participants removed the target the maximum number of times. In a number of cases (P2, P3, P5 and P9), all words in the target network also were removed the maximum number of times and there is a general trend whereby participants removed words in the target network more often than they removed words in other categories, indicating transfer of function. In a number of cases (P1, P4, P6, P7, P8, P10) there was transfer of function from the target to other members of the experimental relational network, but not equally across all members; for example, in a number of cases (P1, P7, P8, P10), there was weaker transfer for one or more of the derived relations than for the trained relation.

Suppression Task Word Removal Latency

Figure 4 shows the mean response latency (in seconds) for seven categories of word in the suppression task (analyses suggested no differences in responding to B2 and C2, the stimuli in derived opposite relations with the target and thus their data were combined): (a) the target (mean = 1.29, SD = 0.30); (b) the trained SAME word (mean = 3.78, SD = 3.41); (c) the derived SAME word (mean = 3.91, SD = 2.73); (d) the average of the two derived OPPOSITE words (mean = 5.41, SD = 2.78); (e) the mean for nontarget network words (mean = 7.67, SD = 1.71); (f) the mean for nonnetwork words, which appeared in training but were not part of either network (mean = 6.05, SD = 2.25); and (g) the mean for novel words, which appeared only in the suppression task (mean = 8.85, SD = 2.31).

Insert Figure 4 about here

Data were analysed using a one way repeated measures ANOVA with word category as the within subjects factor. Mauchly's test indicated that the assumption of sphericity had been violated ($\chi^2(20) = 33.882, p = .04$) and thus degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\epsilon = 0.383$). There was a significant effect of word category ($F [6, 54] = 16.231, p < .001, \eta_p^2 = .643$). The results of pairwise comparison t-tests (LSD) are shown in Table 3. The pattern for removal latency was the same as for frequency. The mean latency for the target was significantly lower than that for all other categories except for the word in a trained same relation, and the latency for all categories in the target network was significantly lower than that for all categories outside the target network (i.e., nontarget network, nonnetwork and novel). This suggests that, as expected, participants were faster to remove the target and words related to it, than to remove words in an alternative relational network, or words that were unrelated or novel.

Insert Table 3 about here

Thus, group level results reveal a pattern in which participants responded quickly to avoid the to-be-suppressed word and were also faster on average to remove words related to that word, whether in relations of sameness or of opposition, than they were to remove words from outside that relational network. With respect to words in the target network, responding was fastest to the target but there were no differences between the mean latencies of the other word categories, once more suggesting comparable transfer of function across derived relations regardless of the nature of these relations (i.e., SAME or OPPOSITE).

Insert Figure 5 about here

Figure 5 shows latency of removal for each of the seven categories of word in the target network (i.e., target, trained same, derived same, derived opposite, nontarget network, nonnetwork and novel) for each individual participant. As may be seen, the target was generally removed faster than any other category of word. In a number of cases (P1, P2, P3, P5, P8, P9), all words in the target network were removed faster than other categories of word, while in other cases (P4, P7) almost all were removed faster. This general pattern thus suggests transfer of function.

Summary & Discussion

The core findings from Experiment 1 were that participants tended to (a) show strongest suppression responding to the target stimulus; and (b) show stronger responding to members of the target network, including words in both same and opposite relations, than to words in other categories including nontarget network, nonnetwork or novel. Assuming the efficacy of the thought suppression intervention early on in the experiment, finding (a) might

have been predicted based on the fact that the target was the only directly conditioned stimulus while finding (b) might have been predicted based on a combination of direct conditioning and transfer of function.

Meantime, there appeared to be no difference in either frequency or latency of thought suppression responding between same and opposite relations. The change in stimulus functions typically seen in the context of opposition relations is qualitatively different from that seen in the context of same. Whereas the latter yields functions similar to those inhering in the original stimulus, the former often yields transformed functions that are contrary along specified dimensions to the functions of the original stimulus. For both of these reasons, if participants were showing a typical transformation of functions through opposition then a pattern whereby they acted to increase the frequency of appearance of the stimuli or extend the length for which they were displayed might have been predicted for stimuli in opposition relations. In the present set-up these actions were not actually possible but at least deliberate inaction with respect to these stimuli might have been expected. The pattern of action seen, whereby stimuli in both same and opposite relations with the target tended to be removed and there was no statistically significant difference between the two for either latency or frequency of removal suggests a transfer rather than transformation of function for both same and opposite relations.

Experiment 1 thus appears to have demonstrated transfer of thought suppression functions through both same and opposite relations. This represents a replication and extension of Hooper et al. (2010) who provided the initial demonstration of transfer of thought suppression functions but who showed this effect via sameness relations alone. This experiment has shown additionally shown a transfer of function via opposition relations. It was predicted that this might happen because the failure of thought suppression suggests that stimuli in opposition relations can acquire functions of the to-be-suppressed stimulus, which

is indicative of transfer rather than transformation of functions. Now we have provided an empirical analog of this process and have also shown once again the importance of contextual control with respect to derived relations based changes in response functions.

One arguable limitation of Experiment 1 was that it facilitated a relatively limited analysis of suppression function transfer via opposite relations. For example, whereas the words in same relations with the target included a word in a trained same relation as well as a word in a relation that was based on the combination of two same relations, there were no words in a trained relation of opposition with the target nor any words related to the target via two relations of opposition. In order to provide a more thorough investigation of the change of functions via opposite relations, a second experiment was conducted in which both these types of relation were included in the target relational network.

EXPERIMENT 2

The purpose of Experiment 2 was to allow for a more thorough investigation of changes in thought suppression functions via derived opposition relations. It was similar to Experiment 1 in most regards. However, it differed in one key respect which was that the target stimulus (which remained the word 'Bear') occupied a different position in the target relational network such that a different set of trained and derived relations would be predicted to emerge and a different set of corresponding changes in thought suppression functions could be tested. More specifically, the target word (i.e., 'Bear') occupied the B2 position (see Figure 1) and thus was trained as 'opposite' to the hub word (i.e., A1) and would be predicted to be in a derived relation of opposition with B1 and C1, and in a derived relation of 'coordination' (via two opposition relations) with C2.

Method

Participants

Eleven individuals participated in the study. Of these, 6 were female and 5 were male and their ages ranged from 17 to 50 years ($M = 32.1$). All participants were volunteers who were contacted through personal acquaintances and chosen on the basis that they had no previous experience or knowledge of derived relations.

Design

As in Experiment 1, both single subject and group analyses were conducted. For the latter, a within subjects design was employed with repeated measures taken on word relation type (target, taught opposite, derived same, derived opposite, nontarget network, nonnetwork, novel). The two dependent variables were frequency and latency of word removal.

Apparatus & Materials

Most details were the same as in Experiment 1. However, the stimuli used in the trained and tested relational networks differed to some extent and, more importantly, the position of the target word 'Bear' within the relational network was changed (see Figure 1 and Table 1).

Procedure

This was identical to that employed in Experiment 1.

Experiment 2: Results & Discussion

All eleven participants passed nonarbitrary relational training and testing on their first attempt. One person (male, age 21) failed to pass arbitrary relational testing for the experimental relational network and was excused. The remaining ten completed two sessions of arbitrary relational training and testing (i.e., one session for the experimental network and one for the control network), with no participant taking more than three cycles of training and testing to reach the criterion of 31/32 correct responses in either session. All ten showed space bar presses ($M = 35.6$) during the 5 minute suppression induction phase and at the end

of the experiment, all correctly reproduced the 9-digit number from the cognitive load manipulation phase, indicating that they had followed the instructions for the latter.

Suppression Task Word Removal Frequency

Figure 6 shows the mean frequency of removals for the following categories of word in the suppression task (analyses suggested no significant differences between B1 and C1, the stimuli in derived opposite relations with the target and thus their data were combined): (a) target (mean = 4.00, SD = 0.00); (b) trained OPPOSITE (mean = 2.9, SD = 1.45); (c) derived SAME (mean = 2.8, SD = 1.75); (d) derived OPPOSITE (mean = 2.2, SD = 1.84); (e) nontarget network (mean = 1.74, SD = 1.72); (f) nonnetwork; (mean = 0.825, SD = 1.42); and (g) novel (mean = 0.66, SD = 1.12).

Insert Figure 6 about here

A one way repeated measures ANOVA revealed a significant effect of word category ($F [6, 54] = 11.386, p < .001, \eta_p^2 = .559$). The results of pairwise comparison t-tests (LSD) are shown in Table 4. This shows that the mean number of responses to the target was significantly higher than that to all other categories except for the word in a derived same relation with it; that the mean number of responses to the trained opposite word was significantly higher than that to all categories other than the target network; that the mean number of responses to the words in derived same and opposite relations was significantly higher than that to words in the nonnetwork and novel categories; and that the mean number of responses to the words in nontarget and nonnetwork categories was significantly higher than that to the novel words.

Insert Table 4 about here

Overall, these group level results suggested that, as in Experiment 1, participants were more likely to remove the target and words related to it than to remove words from other categories, suggesting transfer of function. However, the pattern for this experiment was not as strong or as clear cut as for the previous experiment. In particular there did not appear to be as clear a distinction this time between the target network and the nontarget network.

Insert Figure 7 about here

Figure 7 shows frequency of removal for each of the seven categories of word in the target network (i.e., target, trained opposite, derived same, derived opposite, nontarget network, nonnetwork and novel) for each individual participant. As may be seen, all participants removed the target the maximum number of times. In a number of cases (P1, P2, P3, P5, P6, P10), all or all but one of the words in the target network also were removed the maximum number of times and there is a general trend whereby participants removed words in the target network more often than they removed words in other categories, indicating transfer of function. However, as suggested before, the pattern of acquisition of functions for members of the nontarget relational network seems comparatively stronger in this experiment than in the previous one. For example, in this experiment, there were 4 participants (P1, P2, P9, P10) who appeared to show relatively strong acquisition of functions for the nontarget relational network.

Suppression Task Word Removal Latency

Figure 8 shows mean response latency (measured in seconds) for seven categories of word in the suppression task (separate analyses suggested no significant differences between B1 and C1, the stimuli expected to be in derived opposite relations with the target and thus

their data were combined): (a) target (mean = 2.01, SD = 0.92); (b) trained OPPOSITE (mean = 4.67, SD = 3.04); (c) derived SAME (mean = 3.93, SD = 3.60); (d) derived OPPOSITE (mean = 6.08, SD = 3.64); (e) nontarget network (mean = 6.91, SD = 3.34); (f) nonnetwork (mean = 6.01, SD = 2.75); and (g) novel (mean = 8.88, SD = 1.93).

Insert Figure 8 about here

Data were analysed using a one way repeated measures ANOVA with word category as the within subjects factor. Mauchly's test indicated that the assumption of sphericity had been violated ($\chi^2(20) = 35.832, p = .025$) and thus degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\epsilon = 0.492$). There was a significant effect of word category ($F [6, 54] = 11.934, p < .001, \eta_p^2 = .570$). The results of pairwise comparison t-tests (LSD) are shown in Table 5. The pattern for removal latency is similar to that for frequency. The mean latency to the target was significantly lower than that to all other categories; the mean latency to the trained opposite word was significantly lower than that to all categories other than the target network; the mean latency to words in derived same and derived opposite relations was significantly lower than that to words in the nonnetwork and novel categories; and the mean latency to words in nontarget and nonnetwork categories was significantly lower than that to novel words.

Insert Table 5 about here

These group level results suggest that, as in Experiment 1, participants were faster to remove the target and words related to it than to remove words from other categories, suggesting transfer of function. However, again, the pattern is not as clear cut as for the

previous experiment, with the key difference being that there does not appear to be as clear a distinction this time between the target network and the nontarget network.

Insert Figure 9 about here

Figure 9 shows latency of removal for each of the seven categories of word in the target network (i.e., target, trained opposite, derived same, derived opposite, nontarget network, nonnetwork and novel) for each individual participant. The target was typically removed faster than any other category of word. In addition, in the case of 6 participants (P1, P3, P5, P6, P7, P9), either all or all but one of the words in the target network were removed faster than words in other categories. However, in the case of a number of participants, words in the nontarget network were removed relatively fast also.

Summary and Discussion of findings for Experiment 2

The key findings were that participants tended to (a) show strongest suppression responding to the target stimulus; (b) show stronger suppression responding to members of the target network than to stimuli not in that network including nonnetwork stimuli and novel stimuli; (c) show stronger responding to words that had been involved in arbitrary relational training and testing but were not part of the experimental relational network (i.e., both Nontarget and Nonnetwork) than to words that were previously unseen (i.e., Novel); and (d) show stronger responding to the target than to the word trained to it. It was also noted that, in contrast with Experiment 1, there was a lack of a consistent pattern of statistically significant differences between stimuli in the target relational network and stimuli in the nontarget relational network. While the latter was not a positive finding, it was a potentially important contrast with Experiment 1 and as such it will be referred to as finding (e).

Findings (a) and (b) are similar to some of the findings in Experiment 1, and as with the latter, might have been predicted based on (in the case of [a]) direct conditioning of the target and (in the case of [b]) transfer of function. Findings (c), (d) and (e) show a different pattern from that seen in Experiment 1.

Finding (c) suggests the stimuli in the nontarget relational network and nonnetwork stimuli might have acquired weak suppression functions. This might of course be a statistical artefact given the relatively low numbers used in these experiments. However, assuming that something more is at play then another possible reason for this pattern might be the relative importance of opposition relations in the target relational network during the current experiment as compared with Experiment 1. This might also help explain finding (e). Perhaps the relative importance of opposition relations affected the learning of the relational networks involved, and as a result produced less of a clearcut difference between stimuli inside and outside particular relational networks.

In the case of finding (e), this may have been exacerbated by the fact that due to the training of stimuli from the two networks alongside each other, it is possible that the two relational networks involved might function under certain circumstances as one large network. Under such conditions, it is possible that it is nodal distance from the target rather than differences between distinctive networks that produces differences in levels of transfer of function. This could perhaps have affected Experiment 1 also; however, because the relational networks in that case were based more on coordination than opposition, the differences between the networks may have been clearer and hence there was less transfer from the target to members of the nontarget network. In the case of finding (c), the relative importance of opposition relations in the network might have meant less of a clear cut difference between stimuli inside the trained and tested relational networks and stimuli

outside those networks and thus resulted in the latter becoming more apparently different from completely novel stimuli.

Furthermore, finding (d) might further support an explanation cast in terms of the effect of opposition relations in the relational network. This finding was that there was a significant difference in suppression functions between the target and the word trained to it. This difference appeared in Experiment 2 but not in Experiment 1 and the reason may have been the type of relation trained. In Experiment 1, the trained relation was a sameness relation whereas in Experiment 2 it was an opposition relation. Assuming once again, that this is not a statistical artefact, it is at least possible that the difference in the type of relation involved may have played a role.

Apart from the relatively greater influence of opposition relations in the relational network, another factor contributing to the difference in the pattern of results seen in Experiment 2 might of course have been processes described within Wegner's original ECH. Stimuli outside the trained and tested relational networks might have been responded to as 'different' from any of the stimuli within those networks and thus, at least temporarily, as more effective distractors than stimuli inside the relational network. However, the very fact of such earlier established relations with the relational networks including the target might eventually have caused them to function less effectively as distractors than stimuli that would have been completely novel during the suppression phase.

In summary, Experiment 2 appears to have extended the results of Experiment 1 by demonstrating a transfer of thought suppression functions via trained relations of opposition. However, in both experiments, and particularly Experiment 2, stimuli outside of the target relational network, including members of a second unrelated (nontarget) network as well as nonnetwork stimuli, appeared to acquire thought suppression functions also. Some possible explanations for these patterns have been discussed.

One criticism of both experiments reported so far is that, though they appear to have involved opposition relations, neither of them showed a typical pattern of transformation of functions through opposition. Of course a key aim of the current work is to show that under certain circumstances, opposition relations may produce transfer rather than transformation of functions; however, in order to provide the clearest evidence that this is indeed the case, it seems important to show conclusively that the relations produced under such circumstances are indeed relations of opposition and thus can still result in a conventional pattern of transformation of functions in at least some contexts. That was the aim of Experiment 3.

EXPERIMENT 3

Experiment 3 aimed to extend the results of the previous two experiments. The latter appear to show transfer of function via relations of opposition; however, as this is an atypical pattern more typical of coordination than opposition then one possible criticism might be that the relations demonstrated were not functioning as opposition relations at any stage. The aim of Experiment 3 was to investigate the possibility of showing a conventional transformation of functions through opposite relations alongside the transfer of thought suppression functions through these same relations, thus demonstrating that the latter did function as relations of opposition in at least some contexts.

To do this, Experiment 3 involved first training and testing discriminative functions of selecting along an auditory nonarbitrary dimension (i.e., selecting a button producing either 1, 2 or 3 electronic ‘peals’) in several textual stimuli including the word ‘Bear’. This established functions in the latter such that there might be a transformation of functions of other stimuli subsequently established as participating in either Same or Opposite relations with ‘Bear’. Participants were then trained and tested for arbitrarily applicable relational responding in accordance with Same and Opposite before being re-exposed to the test for discriminative functions. If participants immediately showed the predicted changes in response functions

then they were exposed to the same thought suppression protocol as described in the earlier experiments. If not, they were re-exposed to Same and Opposite relational training and testing. Apart from this key difference between this experiment and the previous ones, in the former, the relational training and testing protocol used was the Relational Completion Procedure (RCP; Dymond & Whelan, 2010). It was decided to use this rather than matching to sample in order to expedite participants' progress.

Method

Participants

10 individuals participated in the study. Of these, 3 were male and 7 were female and their ages ranged from 16 to 50 years ($M = 26.1$). All participants were volunteers who were contacted through personal acquaintances and chosen on the basis that they had no previous experience or knowledge of derived relations.

Design

As in previous experiments, both single subject and group analyses were conducted. For the latter, a within subjects design was used with repeated measures taken on word relation type (target, taught opposite, derived same, derived opposite, nontarget network, nonnetwork, novel). The dependent variables were frequency and latency of word removal.

Apparatus & Materials

The new function training stage included two novel nonsense stimuli: Sackol (X1), Wilfop (X2). In the training and testing of the relational networks, the stimuli used once again differed to some extent from the previous experiments but, importantly, the position of the target 'Bear' within the relational network was the same as in Experiment 2 (see Table 1).

Procedure

In this experiment, participants were exposed to a multiphase procedure as follows: (i) Initial function training & testing; (ii) Relational Completion Procedure (RCP) training &

testing; (iii) Follow-up function training & testing; (iv) Suppression induction; (v) Cognitive load induction; (vi) Suppression task.

Phase (i): Initial function training & testing.

In the training phase, participants were exposed to a matching-to-sample training format on each trial of which one of three textual stimuli, either X1 ('Sackol'), B2 ('Bear') or X2 ('Wilfop') would appear as the sample in the screen centre. After the participant pressed the centre stimulus the comparisons would appear. These were three red square stimuli, which would appear in three randomly chosen corners of the screen, each accompanied by an auditory stimulus, either one chime, two chimes or three chimes. Reinforcement ('Correct' in the screen centre) was contingent on choosing the 'one chime' square given Bear (B2), the two chime square given Sackol (X1) and the three chime square given Wilfop (X2).

After participants achieved 18 consecutively correct responses, the testing phase began. This involved exactly the same format but (i) instead of the quasirandom presentation of X1, B2 and X3 as samples, the sample array included A1 (Casors), B2 (Bear), C2 (Vartle), B1 (Lorald) and C1 (Heiter); (ii) each sample was presented three times in a quasirandom order to give a total of 15 trials; (iii) correct responding was counted as 100% correct responding in accordance with the relational network to be trained and tested in the next phase (see Phases [ii] and [iii]); (iv) no consequences were provided. Because correct responding was predicted to require transformation of function in accordance with the trained and tested network in Phase (ii), it was predicted that participants would fail to show the correct responding in this phase.

Phase (ii): Relational Completion Procedure (RCP) training & testing.

After participants finished Phase (i) testing, the experimenter initiated Phase (ii). At the start, the following instructions were presented onscreen.

Thank you for agreeing to participate in this study. You will be presented with a series of images or nonsense words on the top half of the screen from left to right. Then you will be presented with five images or nonsense words on the bottom of the screen. Your task is to observe the images or words that appear from left to right and drag one of these images or words from the bottom to the blank yellow square. Click and hold the mouse over the image or word to drag it to the blank square. To confirm your choice, click 'Finish Trial'. If you wish to make another choice, then click 'Start Again'. Sometimes you will receive feedback on your choices, but at other times you will not. Your aim is to get as many tasks correct as possible. It is always possible to get a task correct, even if you are not given feedback.

Clicking on a box at the bottom of the screen cleared the instructions and then, 3 seconds later, stage 1 of the REP started.

Throughout the REP protocol, the screen was divided into two areas, with the top two thirds blue and the remainder grey. The sample appeared on the upper left, followed 1 s later by the contextual cue in the upper centre, and followed another 1 s later by a blank comparison square on the upper right. Three comparisons appeared simultaneously in random order across the bottom of the screen. Participants had to drag one of the three comparisons into the blank square using the mouse. When the comparison was dropped onto the blank square, the confirmatory response requirement was initiated: two buttons appeared near the bottom of the screen displaying the captions 'Finish Trial' and 'Start Again' respectively. Pressing 'Start Again' reset the trial to the start, while pressing the 'Finish Trial' button cleared the screen and produced either the feedback screen (in training) or an ITI (in testing). The feedback screen involved the sample, contextual cue and selected comparison arranged left to right, along with either 'Correct' or 'Wrong' as appropriate. During the ITI, the screen was cleared for 3 s.

Participants were required to proceed through two four-stage cycles of RCP training and testing. Participants successful in Cycle 1 advanced to Cycle 2 while those successful in Cycle 2 advanced to the remainder of the experiment. Analogous to the training and testing of the Same / Opposite relational network in Experiments 1 and 2, Cycle 1 focused on the target arbitrary relational network while Cycle 2 focused on the control arbitrary relational network.

Cycle 1. During nonarbitrary training (Stage 1), the samples and comparisons were pictures of shapes or objects that differed along a nonarbitrary dimension (e.g., size). A number of stimulus sets were presented in random order. When participants achieved eight consecutive correct responses they advanced to nonarbitrary relational testing (Stage 2). This was the same as the first stage except that no feedback was provided (i.e., after the response the protocol advanced straight to the ITI) and new stimulus sets were employed. Participants had to achieve 100% correct in the eight trials presented in order to advance; otherwise they were re-exposed to Stage 1. During arbitrary relational training and testing (Stages 3 and 4 respectively), the samples and comparisons were the stimuli listed earlier in the Apparatus and Materials. In Stage 3, participants were exposed to the following eight training trials: SAME / A1-[B1-B2-N1]; SAME / A1-[C1-C2-N2]; OPPOSITE / A1-[B1-B2-N1]; OPPOSITE / A1-[C1-C2-N2]; SAME / X3-[Y3-B1-N3]; SAME / X3-[Z3-C1-N3]; OPPOSITE / X3-[Y4-B2-N3]; OPPOSITE / X3-[Z4-C2-N3]. Training took place in blocks of eight trials, with each trial type presented twice per block. Participants had to pick the correct comparison across eight consecutive trials before they could advance to the next and final stage. In arbitrary relational testing (Stage 4), responses were not reinforced and participants were exposed to the following eight test trials: SAME / B1-[C1-C2-N1]; SAME / C1-[B1-B2-N1]; SAME / B2-[C1-C2-N1]; SAME / C2-[B1-B2-N1]; OPPOSITE / B1-[C1-C2-N1]; OPPOSITE / C2-[B1-B2-N1]; OPPOSITE / B2-[C1-C2-N1]; OPPOSITE / C1-[B1-B2-N1].

Participants scoring 22/24 (92%) were deemed to have passed and advanced to Cycle 2; those failing to reach this criterion were re-exposed to all stages of Cycle 1.

Cycle 2. Stages 1 and 2 were the same as in Cycle 1. Stages 3 and 4 were identical in format to the same stages in Cycle 1, but differed in terms of the relational networks, with Cycle 2 concentrating on the control rather than the experimental network. Thus, in Stage 3, participants were exposed to the following eight training trials: SAME / X3-[Y3-Y4-N3]; SAME / X3-[Z3-Z4-N4]; OPPOSITE / X3-[Y1-Y2-N3]; OPPOSITE / X3-[Z3-Z4-N4]; SAME / A1-[B1-Y3-N1]; SAME / A1-[C1-Z3-N1]; OPPOSITE / A1-[B2-Y4-N1]; OPPOSITE / A1-[C2-Z4-N1]. In Stage 4, participants were exposed to the following eight test trials: SAME / Y3-[Z3-Z4-N3]; SAME / Z3-[Y3-Y4-N3]; SAME / Y4-[Z3-Z4-N3]; SAME / Z4-[Y3-Y4-N3]; OPPOSITE / Y3-[Z3-Z4-N3]; OPPOSITE / Z4-[Y3-Y4-N3]; OPPOSITE / Y4-[Z3-Z4-N3]; OPPOSITE / Z3-[Y3-Y4-N3]. Participants scoring 22/24 (92%) were deemed to have passed and advanced to the remaining stages of the experiment. It was intended that those failing to reach this criterion would have been re-exposed to all stages of Cycle 1 but no participant failed the second cycle.

Phase (iii) Follow-up function training & testing.

This was identical to initial function training and testing. As explained at the end of Phase (i), correct responding during the testing stage was counted as 100% responding in accordance with the relational network trained and tested in Phase 2. The following stimuli were samples during the testing stage: A1 (Casors), B2 (Bear), C2 (Vartle), B1 (Lorald) and C1 (Heiter) while the comparisons were the three auditory stimulus buttons that produced either 1, 2 or 3 chimes. In Phase (ii), the target B2 was trained as opposite to A1, a coordination relation was derived between B2 and C2 and opposition relations were derived between B2 and B1 and B2 and C1. Because B2 was trained to have an auditory stimulus function of “1 chime”, and thus in a context in which the choice was between 1, 2 or 3

chimes, then 3 chimes might be predicted to function as opposite to 1 chime, the following pattern of transfer and transformation of functions would be expected: A1 (opposite, 3 chimes), C2 (same, 1 chime), B1 (opposite, 3 chimes), C1 (opposite, 3 chimes). If participants responded 100% in accordance with this pattern then they advanced to the next phase of the experiment. If not, they were re-exposed to Phase (ii) RCP training and testing. Phases (iv-vi) Suppression induction, cognitive load induction and suppression task.

These were the same as for Experiments 1 and 2.

Experiment 3: Results & Discussion

All ten participants failed Phase (i) Initial function training and testing as predicted. In Phase (ii) RCP training and testing, eight participants passed nonarbitrary training and testing on their first exposure in Cycle 1, while of the remaining two, P9 required one further exposure, while P5 required two further exposures. Six participants required one exposure to Cycle 1 arbitrary training and testing to advance to Cycle 2, while of the remaining four, P1 and P9 required one further exposure, P3 needed two further exposures and P4 required four further exposures. All ten participants passed all stages of Cycle 2 first time. In Phase (iii) Follow-up function training & testing all ten participants passed with minimal trials needed.

All participants showed space bar presses ($M = 28.4$) during the Phase (iv) 5 minute suppression induction phase and at the end of the experiment, all could at least near correctly reproduce the 9-digit number they were required to memorize in the Phase (v) cognitive load manipulation phase, indicating that they had followed the instructions.

Suppression Task Word Removal Frequency

Figure 10 shows mean frequency of removals for seven categories of word in the suppression task (analyses suggested no differences between B1 and C1, the stimuli in derived opposite relations with the target and thus their data were combined): (a) target (mean = 3.9, SD = 0.32); (b) trained OPPOSITE (mean = 3, SD = 1.63); (c) derived SAME (mean =

2.6, SD = 1.35); (d) derived OPPOSITE (mean = 2.1, SD = 1.56); (e) nontarget network (mean = 1.3, SD = 1.34); (f) nonnetwork; (mean = 0.45, SD = 1.44); and (g) novel (mean = 0.34, SD = 0.38).

Insert Figure 10 about here

Data were analysed using a one way repeated measures ANOVA with word category as the within subjects factor. Mauchly's test indicated that the assumption of sphericity had been violated ($\chi^2(20) = 37.302, p = .018$) and thus degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\epsilon = 0.524$). There was a significant effect of word category ($F [3.141, 28.27] = 16.119, p < .001, \eta_p^2 = .642$). The results of pairwise comparison t-tests (LSD) are shown in Table 6. This shows that the mean number of responses to the target was significantly different than that to all other categories except for the trained opposite word; that the mean number of responses to words in trained opposite and derived same relations was significantly higher than that to all categories other than the target network; that the mean number of responses to words in derived opposite relations was significantly higher than that to words in the nonnetwork and novel categories; and that the mean number of responses to nontarget words was significantly higher than that to the nonnetwork and novel words.

Insert Table 6 about here

Overall, these group level results suggest that, as in Experiments 1 and 2, participants were more likely to remove the target and words related to it than to remove words from other categories, suggesting transfer of function. Once again though, as for Experiment 2, the

pattern is not as strong or as clear cut as for the first experiment, for which there was a clearer distinction between the target network and the nontarget network, for example.

Insert Figure 11 about here

Figure 11 shows frequency of removal for each of the seven categories of word in the target network (i.e., target, trained opposite, derived same, derived opposite, nontarget network, nonnetwork and novel) for each individual participant. As may be seen, all participants except one removed the target the maximum number of times. In a number of cases (P1, P2, P3, P4, P5, P6, P10), the trained opposite word was also removed the maximum number of times. The derived members of the target network were removed less frequently but there are still strong trends for them also; for example, the derived same word was removed at least twice by seven participants while the derived opposite words were removed at least twice by six participants. In addition, as in Experiment 2, there was a general trend whereby participants removed words in the target network more often than they removed words in other categories, indicating transfer of function. However, as suggested above, the pattern of acquisition of functions for members of the nontarget relational network seems relatively stronger in this experiment than in Experiment 1. For example, there are 3 participants (P4, P5, P7) who appear to show relatively strong acquisition of functions for the nontarget relational network.

Suppression Task Word Removal Latency

Figure 12 shows mean response latency (in seconds) for seven categories of word in the suppression task (analyses suggested no differences between B1 and C1, the stimuli in derived opposite relations with the target and thus their data were combined): (a) target (mean = 1.93, SD = 0.94); (b) trained OPPOSITE (mean = 4.63, SD = 3.12); (c) derived SAME

(mean = 5.28, SD = 2.98); (d) derived OPPOSITE (mean = 6.55, SD = 2.74); (e) nontarget network (mean = 7.78, SD = 2.41); (f) nonnetwork (mean = 6.82, SD = 0.72); and (g) novel (mean = 9.52, SD = 0.54).

Insert Figure 12 about here

Data were analysed using a one way repeated measures ANOVA with word category as the within subjects factor. Mauchly's test indicated that the assumption of sphericity had been violated ($\chi^2(20) = 43.929, p = .003$) and thus degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\epsilon = 0.480$). There was a significant effect of word category ($F [2.88, 25.916] = 18.656, p < .001, \eta_p^2 = .675$). The results of pairwise comparison t-tests (LSD) are shown in Table 7. The pattern for removal latency was similar to that for frequency though not identical. The mean latency to the trained opposite word was significantly lower than that to all categories other than the target network; the mean latency to the words in derived same and derived opposite relations was significantly lower than that to words in the nonnetwork and novel categories; and the mean latency to words in nontarget and nonnetwork categories was significantly lower than that to novel words.

These group level results suggest that, as in the previous experiments, participants were faster to remove the target and words related to it than to remove words from other categories, suggesting transfer of function. Once again, though, the pattern is less clear than for Experiment 1, with less difference between the target and nontarget networks.

Insert Table 7 about here

Figure 13 shows latency of removal for each of the seven categories of word in the target network (i.e., target, trained opposite, derived same, derived opposite, nontarget network, nonnetwork and novel) for each individual participant. The target was typically removed faster than any other category of word. In addition, in the case of 7 participants (P1, P2, P3, P5, P6, P7, P10), either all or all but one of the words in the target network were removed faster than words in other categories. However, in the case of a number of participants, words in the nontarget network were removed relatively fast also.

Insert Figure 13 about here

Summary and Discussion of findings for Experiment 3

Experiment 3 aimed to extend the results of Experiments 1 and 2 by showing a conventional pattern of transformation of functions through opposition relations alongside the transfer of thought suppression functions through these same relations shown in the previous two experiments. To do this, ten novel participants were recruited and were first trained and tested for discriminative functions (of selecting along an auditory nonarbitrary dimension) in several textual stimuli including the word 'Bear'. They were then trained and tested for arbitrarily applicable relational responding in accordance with Same and Opposite using the Relational Completion Procedure before being re-exposed to the test for discriminative functions. All ten participants showed a transfer and transformation of functions of stimuli participating in Same or Opposite relations, respectively, with 'Bear'. They were then exposed to the same thought suppression protocol as previous participants had received and in the final stage of the latter showed a similar pattern of transfer of functions throughout the relational network as shown by these earlier participants and in particular those in Experiment 2, for whom the Same Opposite relational network established was identical.

Experiment 3 thus contributes to this overall study in two respects. First, it replicates the pattern of transfer of functions through derived same and opposition relations seen in the first two experiments and in particular the pattern seen in Experiment 2. Second, it juxtaposes the demonstration of this effect of transfer through both same and opposite relations with the demonstration of a pattern of transfer through same and a predicted pattern of transformation through opposite, thus providing more definitive evidence that the relational pattern seen throughout all three experiments did indeed involve opposition relational responding in at least some contexts and hence that in the context of derived thought suppression, even relations established as nominally opposite can result in transfer rather than transformation of functions.

GENERAL DISCUSSION

Previous research demonstrated transfer of thought suppression functions via derived equivalence relations (Hooper et al., 2010). In so doing, it extended work by Wegner and colleagues (1991; 1992) by empirically modelling a process of indirect thought suppression interference. However, from a Relational Frame Theory perspective, equivalence or sameness relations are only one type of derived relation and other types may be even more relevant than equivalence as regards indirect emergence of thought suppression functions in particular. For example, it might be supposed that someone trying to suppress a thought would think of something that is opposite to the suppression target along one or more important dimensions. For instance, someone trying to suppress a depressing thought might think of something happy or joyful, while someone trying to suppress an anxiety-provoking thought might imagine something safe or relaxing. Hence, given the potential importance of the relation of opposition in this regard, the current study examined transformation of thought suppression functions via trained and derived opposition relations.

In Experiment 1 participants were trained and tested for formation of two five-member relational networks composed of ‘same’ and ‘opposite’ relations. They were subsequently instructed to suppress a target word, which had previously appeared in one of the two relational networks, while a number of words appeared on the screen in front of them in a quasirandom cycle including the target, and words either in the same (target) relational network or in a different (nontarget) relational network. As in Hooper et al. (2010), participants were allowed to remove any word that appeared on the screen by pressing the computer spacebar. Findings showed that participants removed the target more frequently and faster than other words; removed words in trained relations with the target more frequently and faster than words in derived relations with it; removed words in ‘same’ relations with the target more frequently and faster than words in ‘opposite’ relations with it; and removed words in the target relational network more frequently and faster than words in the nontarget relational network.

One arguable limitation of Experiment 1 was that there was only one derived relation of opposition in the experimental network and thus it did not allow a very comprehensive investigation of transformation of function via opposite relations. The purpose of Experiment 2 was to allow for a more thorough investigation of change of thought suppression functions via relations of opposition. In this experiment, the target word was trained as ‘opposite’ to the hub word in the relational network and thus (a) all the ensuing derived relations and changes of function were based on a trained relation of opposition and (b) the network involved primarily relations of opposition rather than relations of sameness. Experiment 2 appeared to extend the results of Experiment 1 by demonstrating a transfer of thought suppression functions via trained relations of opposition as well as via a derived sameness relation that was itself based on two opposite relations. The overall pattern was arguably slightly weaker than in Experiment 1, but this might be argued to be a function of the dominant presence of opposition relations in the relational network. As seen in Experiment 1, there appeared to be a weaker transfer of function for relations of

opposition and because such relations predominated in the target network in Experiment 2 then this may explain the weaker overall pattern seen for this experiment.

One of the criticisms of both Experiments 1 and 2 was that, because they only showed a transfer of functions via purported relations of opposition, then perhaps the relations demonstrated were not opposition relations. The aim of Experiment 3 was to investigate the possibility of showing a conventional transformation of functions through opposite relations alongside the transfer of thought suppression functions through these same relations, thus demonstrating that the latter functioned as relations of opposition in at least some contexts. To this end, ten novel participants were first trained and tested for discriminative functions in several textual stimuli including the word 'Bear'. They were then trained and tested for arbitrarily applicable relational responding in accordance with 'same' and 'opposite' using the Relational Completion Procedure before being re-exposed to the test for discriminative functions. All ten showed a transfer and transformation of functions of stimuli participating in 'same' or 'opposite' relations respectively with 'Bear'. They were then exposed to the same thought suppression protocol as previous participants had received and showed a similar pattern of transfer of functions throughout the relational network as shown by these earlier participants and in particular those in Experiment 2, for whom the Same Opposite relational network established was identical. Experiment 3 thus replicated the pattern of transfer of functions through derived same and opposition relations seen in the first two experiments and in particular the pattern seen in Experiment 2 and constituted evidence that the relational pattern seen throughout all three experiments was indeed opposition and that in the context of derived thought suppression, opposition relations can result in transfer rather than transformation of functions.

Overall, these results provide evidence of the transfer of thought suppression functions via same and opposite relations. This adds to previous research on transfer of

thought suppression functions through derived relations as shown by Hooper et al. (2010). It provides additional evidence for this process, but arguably now in the context of opposition. Examining derived thought suppression in this context seems important because it seems likely that people will often try to suppress thoughts by thinking of something that is the opposite of or at least as different as possible from, the to-be-suppressed thought. Furthermore, bearing the latter in mind, there are a number of additional points that might be made in relation to the work done in the current study.

First, because what people might try to do is think of something in a direct relation of opposition from the to-be-suppressed stimulus, then it would seem that the second and third experiments in the current study, both of which involved a trained relation of opposition between the target and the remainder of the network, would be a closer model of 'real life' thought suppression via opposition relations than Experiment 1. However, this suggestion might itself be further empirically explored in future research using the current paradigm, by, for example, requiring people to suppress particular real world concepts through distraction and examining the actual relational networks involved.

Second, the results from this study suggest that transfer of function in accordance with opposition, in those circumstances in which it occurs, might not be quite as strong or robust as transfer of function in accordance with coordination (sameness) relations. Two suggestions are provided for why this might be. One concerns the typical learned pattern of opposition relations. In a typical transformation of functions via opposition, the second stimulus does not typically acquire the same functions as the initial stimulus but instead acquires functions that are contrary to those of the latter along a particular dimension. Of course, it is also possible that in certain contexts such as thought suppression there may be a transfer of functions via opposite rather than a transformation of functions. Nevertheless, it seems possible that given the typical kind of training history characterising opposition relations that at the very least the

transfer of functions involved might be weaker or otherwise different from that seen for sameness relations. The second suggestion as to the reason for the weakness or ambivalence of opposition relations is that they are less frequently encountered or used in language and may therefore simply not be as well trained as other relations such as coordination. Perhaps both of these might contribute to the weakness of the transformation of functions.

The finding that opposition relations may yield a weaker transfer of functions than other types of relations might suggest that to at least some extent, they may be more effective with regard to thought suppression. However, two points need to be borne in mind with respect to this suggestion. First, even though yielding weaker transfer, they still reliably yielded this effect across the three experiments. Second, the model of derived thought suppression examined in this study examined this phenomenon happening for a limited period of time. This was deliberately done in order to examine the phenomenon of derived relational responding, which happens in its purest form the first time. However, in everyday life, the same distractor may be used repeatedly thus strengthening the relations involved such that eventually the type of relations initially involved may not matter as much. The possibility that additional exposure to the procedures involved here might mean similar levels of thought suppression despite the relations involved initially is something that additional research should explore.

This research did not simply examine results at a group level but also examined findings at the level of the individual. Adding to the relative clarity of the results at a group level, in each of the experiments, there were clear cut examples of the transfer of functions via same and opposite relations, both trained and derived, at the level of the individual also. Naturally, however, there was also variability in performance such that in the case of some individuals, the predicted pattern of transfer of functions was not seen. Such individual variability certainly warrants further investigation. It is possible that in the case of some

participants, there was a lack of attention to the instructions or a lack of rule following. During an experimental cycle, participants were required to pay close attention to the computer screen for a period of almost twenty minutes during the suppression task, which followed a lengthy procedure of training and testing arbitrary relations. Thus, it is perhaps not surprising that there might have been variation in attention and or adherence to instructions. To investigate this further and isolate the processes of interest more effectively, it would be advisable for future research using this type of protocol to use adherence measures.

The current research also supplements previous RFT work on transfer and transformation of function. At this point there is evidence of derivation of multiple different relations and the transfer and transformation of multiple different functions via that multiplicity of different relations. The current work supplements previous work on the transfer and transformation of functions via same and opposite respectively (e.g., Barnes-Holmes, Barnes-Holmes & Smeets, 2004; Dymond & Barnes, 1995; Dymond, Roche, Forsyth, Whelan & Rhoden, 2007). However, in the context of thought suppression functions, the change of functions via opposition is unusual and thus, as suggested earlier, exploring this phenomenon is particularly interesting. Trying to distract oneself by thinking of something that is opposite to the target stimulus often fails for the same reason as trying to distract oneself by thinking of something in any other relation with the target - because eventually the distractor stimulus gains some of the functions of the target. Thus, in the context of thought suppression, stimuli in opposition relations with a stimulus can come to acquire similar functions to that stimulus. However, this is an atypical pattern of change of functions in the context of opposition (see e.g., Hayes, Barnes-Holmes & Roche, 2001), because under typical circumstances, the transformation of functions via opposition produces a function that is in some sense the contrary of the original function.

Despite this apparently unusual pattern however, this phenomenon is consistent with RFT, which stresses the importance of context for all patterns of transfer and transformation of function and thus if there are contexts in which opposition relations yield atypical patterns then this is simply an additional and potentially useful empirical finding regarding opposition relations and relational responding more generally. Indeed, the results of one previous RFT study cohere well with the current findings. As stated in the introduction, the current study used a procedure for training and testing relations of sameness and opposition relations similar to that employed by Whelan, Cullinan, O'Donovan, and Valverde (2005). The latter researchers demonstrated priming effects based on derived relations of sameness and opposition whereby participants responded more quickly to pairs of arbitrary stimuli if they were in either directly trained or derived relations of either sameness or opposition than if unrelated. This phenomenon of priming is directly relevant to the current paradigm also since thought suppression interference can also be conceptualised as a type of priming, albeit with different response outcomes. As such, the results of Whelan et al. (2005) might even have been used to predict the current outcome.

In any event, it might also be suggested that even though the change in functions via opposition relations is similar in the context of thought suppression to that in functions via coordination relations, there may still be functionally important differences between the two. For example, as has been discussed, the evidence suggests that the change in functions via opposition may be weaker at least initially than that for coordination. There were a number of possible reasons why this might be the case explored earlier. It is also possible that exposure to additional relations of opposition might modulate this difference so that the atypical pattern of change of functions might become less pronounced or more pronounced. In any event, this is an area that future research might explore.

These results provide further empirical evidence of the futility of thought suppression. A number of additional points need to be made in this regard. One concerns the label “thought suppression” itself. The current research has used this term to refer to a broad conceptualization of self-control of thinking. However, Wegner (1989) drew a distinction between subtypes including suppression (“I will not think of X”) and distraction (“I will think of Y”) and, for example, suggested that thought suppression more broadly conceptualized probably involves moving from the first to the second. The current study could be argued to have concentrated more on the second than the first. This can be justified as this is a particularly common strategy of thought suppression conceptualised more broadly (Rachman & De Silva, 1978) and also because this study is an extension of previous work focusing more on how derived relations impact on thought suppression than on modelling the phenomenon itself completely. Nevertheless, future research could perhaps use the paradigm employed here as a basis for further exploration of this distinction.

This is related to a second point that could be made regarding the investigation of thought suppression in the current study. While objective measures of thought suppression were enabled through recording of bar press activity, additional information concerning the processes at work might have been provided by having participants report on the strategies which they employed in order to avoid thinking about the target during the suppression phase. Such reports might have provided information on the frequency of use of suppression versus distraction strategies both within as well as across participants. It might have provided more detailed information concerning the extent to which particular stimuli acted as useful distractors as opposed to causing the failure of thought suppression. Such information might help explain patterns of responding seen in the findings of the current study. For example, there appeared to be low level but nonetheless detectable responding towards stimuli that did not participate in the relational networks. Perhaps aspects of Wegner’s basic ECH theory or

other theoretical conceptualizations might help explain these effects. Clues might be provided by soliciting verbal descriptions from participants so this is therefore a recommendation for future work with this paradigm.

As has been suggested, these findings provide further empirical evidence of the futility of thought suppression. They also provide further evidence of the contention by many third wave approaches to psychotherapy, including Acceptance Commitment Therapy (Hayes, Strosahl & Wilson, 1999; Hayes, 2004), for example, that stress the importance of acceptance rather than control as an approach to unwanted thoughts. RFT provides a technical explanation for why this is the case. From an RFT perspective, responding relationally always involves at least two key forms of contextual control. One is control over the derivation of the relations itself, which is referred to as C_{rel} control. For example, in the statement 'A is the same as B', a key cue for the relation to be derived is the word 'same'. The second form of contextual control concerns which functions are transformed via this relation. This is referred to as C_{func} control. For example, in a context in which A is a thought that I am trying to avoid, then because B has been derived as being the same as A then B may acquire similar functions such that I come to want to avoid B also. On the other hand, in a context in which I can accept the thought A then I can also accept the thought B. Traditional second wave approaches to psychotherapy have been characterised by their emphasis on what RFT would interpret as C_{rel} interventions, in which the therapeutic process is seen as an attempt to change the relations that are derived. For example, if the client suggests that he or she has thoughts that 'I am bad' (the C_{rel} here is 'am') then the therapist might try to provide the client with sufficient evidence to convince him or her that 'I am not bad' or 'I am the opposite of bad' (C_{rel} = 'not' or 'opposite') is a better representation or a 'truer' thought. However, as empirical data such as that provided by the current study suggest, this may ultimately be ineffective because in the context of thought suppression, the relation being

derived (i.e., whether 'same' or 'opposite', for instance) does not matter and ultimately the same problematic avoidance responses that are performed with respect to 'I am bad' will be performed with respect to 'I am not bad'. Rather than C_{rel} interventions, 3rd wave approaches such as ACT tend to instead recommend C_{func} interventions. In this approach the client is encouraged to change the context for thoughts such as 'I am bad' rather than to change the relation derived. For example, he or she might be encouraged to respond to particular thoughts with acceptance rather than suppression or avoidance. From this perspective, this change in the functional context (C_{func}) for such thoughts is ultimately more likely to be successful than changes to the relational (C_{rel}) context because in the long run, the client has more control over processes characterising the former than those characterising the latter.

In conclusion, the current studies have extended previous work by Hooper et al. (2010) who demonstrated derived thought suppression interference via equivalence by providing empirical evidence that this effect occurs not just via coordinate relations but also via noncoordinate and more specifically opposition relations. Future research further exploring issues and implications of these findings for understanding thought suppression and other forms of cognitive control will be important for both basic and applied purposes.

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Table 1.

Words and their categories across Experiments 1 – 3.

	Experiment 1	Experiment 2	Experiment 3
Target	Bear (B1)	Bear (B2)	Bear (B2)
Trained Same	Boceem (A1)	N/A	N/A
Derived Same	Gedeer (C1)	Ronkeb (C2)	Vartle (C2)
Trained Opposite	N/A	Casors (A1)	Casors (A1)
Derived Opposite 1	Murtle (B2)	Lorald (B1)	Lorald (B1)
Derived Opposite 2	Samolt (B2)	Heiter (C1)	Heiter (C1)
Non Target Network	Siflet (X3)	Troper (X3)	Lewoly (X3)
Non-Target Network	Shoe (Y3)	Matser (Y3)	Shoe (Y3)
Non-Target Network	Wroned (Z3)	Lewoly (Z3)	Drager (Z3)
Non-Target Network	Cachen (Y4)	Shoe (Y4)	Troper (Y4)
Non-Target Network	Desund (Z4)	Drager (Z4)	Siflet (Z4)
Non-Network	Sinald (N1)	Sinald (N1)	Rigund (N1)
Non-Network	Surtel (N2)	Rigund (N2)	Matser (N2)
Non-Network	Troper (N3)	Desund (N3)	Wroned (N3)
Non-Network	Vartel (N4)	Betret (N4)	Samolt (N4)
Novel	Wollef	Sipher	Rettes
Novel	Rettes	Surtel	Hook
Novel	Matser	Gedeer	Ronkeb
Novel	Remond	Wollef	Betret
Novel	Casors	Samolt	Flag
Novel	Lewoly	Haveen	Sinald
Novel	Lorald	Boceem	Desund
Novel	Haveen	Vartle	Haveen
Novel	Ronkeb	Cachen	Tree
Novel	Drager	Murben	Murben
Novel	Sipher	Rettes	Surtel
Novel	Heiter	Wroned	Remond
Novel	Rigund	Remond	Cachen
Novel	Betret	Siflet	Boceem
Novel	N/A	N/A	Sipher

Table 2.

Pair-wise comparisons between word categories for response frequency in Experiment 1.

	Target	Same T	Same D	Opp D	NT Net	Non Net	Novel
Target	*						
Same T	NS	*					
Same D	$p = .042$	NS	*				
Opp D	$p = .028$	NS	NS	*			
NT Net	$p = .000$	$p = .005$	$p = .007$	$p = .044$	*		
Non Net	$p = .000$	$p = .011$	$p = .014$	$p = .020$	NS	*	
Novel	$p = .000$	$p = .008$	$p = .009$	$p = .017$	NS	NS	*

Table 3.

Pair-wise comparisons between word categories for response latency in Experiment 1.

	Target	Same T	Same D	Opp D	NT Net	Non Net	Novel
Target	*						
Same T	NS	*					
Same D	$p = .019$	NS	*				
Opp D	$p = .002$	NS	NS	*			
NT Net	$p = .000$	$p = .005$	$p = .003$	$p = .042$	*		
Non Net	$p = .000$	$p = .008$	$p = .006$	$p = .015$	NS	*	
Novel	$p = .000$	$p = .007$	$p = .005$	$p = .022$	NS	NS	*

Table 4.

Pair-wise comparisons between word categories for response frequency in Experiment 2.

	Target	Opp T	Same D	Opp D	NT Net	Non Net	Novel
Target	*						
Opp T	$p = .04$	*					
Same D	NS	NS	*				
Opp D	$p = .013$	NS	NS	*			
NT Net	$p = .002$	$p = .045$	NS	NS	*		
Non Net	$p = .000$	$p = .008$	$p = .012$	$p = .039$	NS	*	
Novel	$p = .000$	$p = .002$	$p = .004$	$p = .010$	$p = .013$	$p = .042$	*

Table 5.

Pair-wise comparisons between word categories for response latency in Experiment 2.

	Target	Opp T	Same D	Opp D	NT Net	Non Net	Novel
Target	*						
Opp T	$p = .021$	*					
Same D	$p = .023$	NS	*				
Opp D	$p = .009$	NS	NS	*			
NT Net	$p = .003$	$p = .046$	NS	NS	*		
Non Net	$p = .000$	$p = .012$	$p = .019$	$p = .04$	NS	*	
Novel	$p = .000$	$p = .002$	$p = .006$	$p = .012$	$p = .027$	$p = .049$	*

Table 6.

Pair-wise comparisons between word categories for response frequency in Experiment 3.

	Target	Opp T	Same D	Opp D	NT Net	Non Net	Novel
Target	*						
Opp T	NS	*					
Same D	$p = .009$	NS	*				
Opp D	$p = .008$	NS	NS	*			
NT Net	$p = .000$	$p = .025$	$p = .027$	NS	*		
Non Net	$p = .000$	$p = .001$	$p = .000$	$p = .003$	$p = .022$	*	
Novel	$p = .000$	$p = .000$	$p = .001$	$p = .008$	$p = .037$	NS	*

Table 7.

Pair-wise comparisons between word categories for response latency in Experiment 3.

	Target	Opp T	Same D	Opp D	NT Net	Non Net	Novel
Target	*						
Opp T	$p = .027$	*					
Same D	$p = .003$	NS	*				
Opp D	$p = .001$	NS	NS	*			
NT Net	$p = .000$	$p = .021$	$p = .037$	NS	*		
Non Net	$p = .000$	$p = .001$	$p = .001$	$p = .003$	$p = .023$	*	
Novel	$p = .000$	$p = .000$	$p = .002$	$p = .009$	$p = .036$	NS	*

Figure Captions

Figure 1. Trained and derived relations between words in the target (left) and non-target (right) relational networks in all three experiments. In Experiment 1, the to-be-suppressed word was B1 while in Experiments 2 and 3, it was B2.

Figure 2. Mean frequency of word removal responses made during the final (thought suppression) phase in Experiment 1 for seven categories of word. The first four are categories of word in the target relational network: ‘Target’ (B1), the to-be-suppressed word; ‘Same T’ (A1), the word in a trained ‘same’ relation with the target; ‘Same D’ (C1), the word in a derived ‘same’ relation with the target; and ‘Opp D’ the mean for the two words (i.e., B2, C2) in a derived ‘opposite’ relation with the target. The remaining three are categories of word from outside the target relational network: ‘NT Net’ is the mean for words in the ‘Nontarget’ relational network (X3, Y3, Z3, Y4, Z4); ‘Non-Net’ is the mean for words in arbitrary relational training and testing that were not part of either established network (N1, N2, N3, N4); and ‘Novel’ is the mean for words that did not appear during training and testing.

Figure 3. Mean frequency of word removal responses made for seven categories of word in the case of each of the ten participants during the final phase in Experiment 1.

Figure 4. Mean latency of word removal responses made during the final phase in Experiment 1 for seven categories of word. The first four (‘Target’ [B1], ‘Same T’ [A1], ‘Same D’ [C1] and ‘Opp D’ [B2, C2]) are categories of word in the target relational network, while the remaining three (‘NT Net’ [X3, Y3, Z3, Y4, Z4], ‘Non-Net’ [N1, N2, N3, N4] and ‘Novel’) are categories of word from outside the target network.

Figure 5. Mean latency of word removal responses made for seven categories of word in the case of each of the ten participants during the final phase in Experiment 1.

Figure 6. Mean frequency of word removal responses made during the final phase in Experiment 2 for seven categories of word. The first four are categories of word in the target

relational network: 'Target' (B2), the to-be-suppressed word; 'Opp T' (A1), the word in a trained 'opposite' relation with the target; 'Same D' (C2), the word in a derived 'same' relation with the target; and 'Opp D' (B1, C1) the mean for the two words in a derived 'opposite' relation with the target. The remaining three are categories of word from outside the target relational network.

Figure 7. Mean frequency of word removal responses made for seven categories of word in the case of each of the ten participants during the final phase in Experiment 2.

Figure 8. Mean latency of word removal responses made during the final phase in Experiment 2 for seven categories of word.

Figure 9. Mean latency of word removal responses made for seven categories of word in the case of each of the ten participants during the final phase in Experiment 2.

Figure 10. Mean frequency of word removal responses made during the final phase in Experiment 3 for seven categories of word (the categories are the same as for Experiment 2).

Figure 11. Mean frequency of word removal responses made for seven categories of word in the case of each of the ten participants during the final phase in Experiment 3.

Figure 12. Mean latency of word removal responses made during the final phase in Experiment 3 for seven categories of word.

Figure 13. Mean latency of word removal responses made for seven categories of word in the case of each of the ten participants during the final phase in Experiment 3.

Figure 1

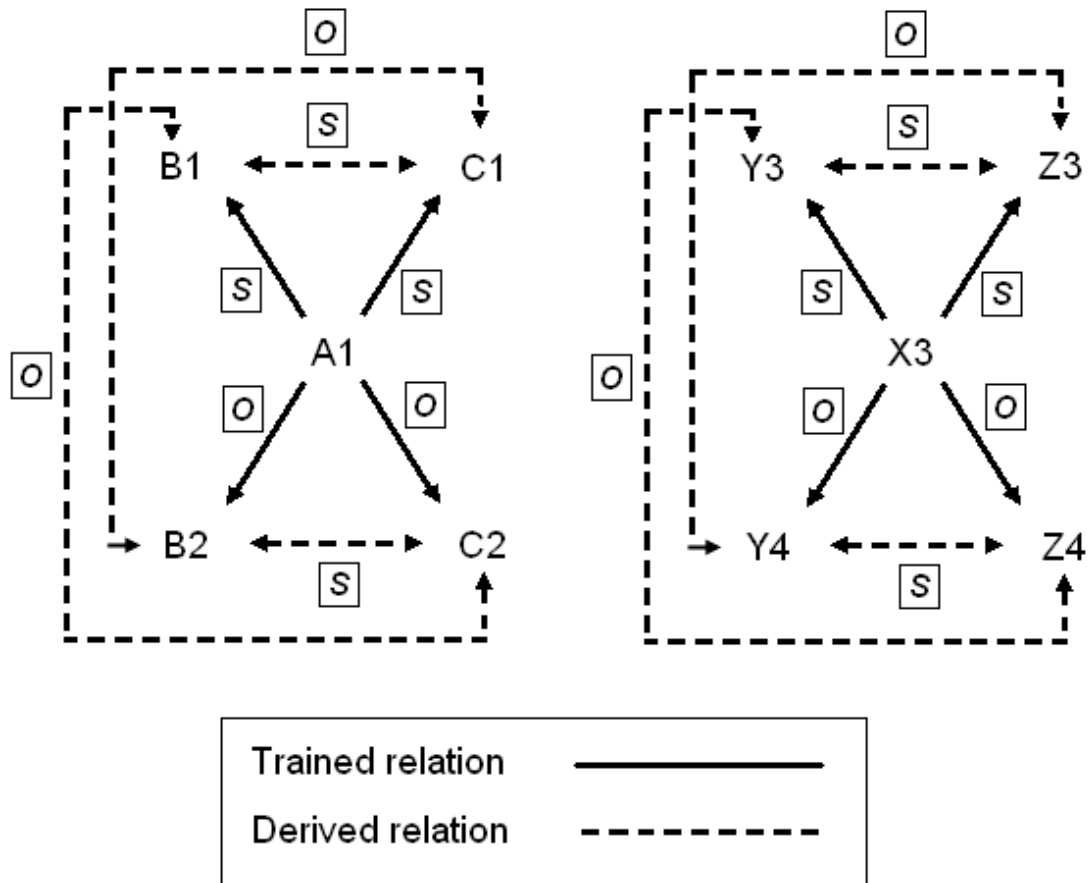


Figure 2

