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How Self-Relevant Imagination Affects Memory for Behaviour

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SUMMARY

Research has demonstrated that imagination can be used to affect behaviour and also to distort memory, yet few studies have examined whether the effects of imagination on behavioural estimates and memory are related. In two experiments, the effects of imagination on self-reported behaviour and subsequent memory for that behaviour were investigated. A comparison of behavioural estimates collected before and after imagination demonstrated that reported estimates of behaviour changed after imagination. In addition, memory for the original estimates of behaviour was also affected, suggesting that imagination may impair one's ability to remember originally reported behaviour. Experiment 2 demonstrated that the observed changes in reported behaviour were accompanied by the largest errors in memory for originally reported behaviour when participants generate images based on self-relevant scenarios. On the other hand, memory distortion was minimized when participants read but did not imagine self-relevant scenarios. These results have direct application to clinicians and researchers who employ imagination techniques as behavioural modifiers, and suggest that techniques that are self-relevant but do not include imagery may be a useful alternative to imagination. Copyright © 2006 John Wiley & Sons, Ltd.

For decades, researchers have been interested in whether imagination, or mental simulation, can influence how we plan, perform, study and behave. Developmental psychologists have studied children's capacity to imagine future events and the ways in which they use those skills to set goals, make plans, fantasize and play (Singer, 1971). Cognitive psychologists have explored how people use imagination and mental simulation in a range of cognitive tasks, including problem solving (e.g. Klein & Crandall, 1995) and planning (Hayes-Roth, 1979). Clinical psychologists have encouraged clients to imagine potentially problematic future situations and to rehearse skills for managing those situations successfully when they are encountered (e.g. Brownell, Marlatt, Lichtenstein, & Wilson, 1986; Marlatt & Nathan, 1978).

Psychologists have also used imagination to directly change behaviour. For example, Sherman & Anderson (1987) found that outpatients at a psychiatric clinic were much less likely to terminate therapy if they imagined staying in therapy and explained why they had stayed.

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While imagination has been shown to be a powerful tool across a wide variety of psychological domains, research in the area of memory has demonstrated that imagination activities can lead to conflicts in memory when the imager can no longer distinguish what was imagined from what actually happened (i.e. Johnson, Hashtroudi, & Lindsay, 1993). The present study explores conflicts in memory that arise due to imagination tasks designed to change self-report behavioural assessments. Specifically, while imagination may significantly alter behaviour, the present study examines whether imagination may also alter memory for behaviour, leading to inaccuracies in self-report assessments of behaviour.

BELIEFS AND BEHAVIOUR

Several studies have demonstrated that our personal beliefs are susceptible to the influences of imagination. Research has demonstrated that people who imagine hypothetical events are more likely to endorse future occurrence of those events than are people who performed other cognitive tasks related to event occurrence (Anderson, 1983; Carroll, 1978; Gregory, Cialdini, & Carpenter, 1982; Hirt & Sherman, 1985; Sherman, Cialdini, Schwartzman, & Reynolds, 1985; Sherman, Skov, Hervitz, & Stock, 1981; see Koehler, 1991 for review). For example, when participants were presented with one of two hypothetical outcomes for the 1976 presidential election depicting either Ford or Carter as the election-day victor, those participants who imagined Ford's victory indicated with more certainty that Ford would win the election, while those who imagined Carter's victory predicted that Carter would be the next president (Carroll, 1978). Additionally, participants encouraged to imagine experiencing the symptoms associated with a particular disease believed it was more likely that they would actually contract the disease than those who merely read a description of the same symptoms (Sherman et al., 1985).

Research also suggests that behaviour, as well as beliefs, can be modified through imagination. For example, participants were more likely to request a free week-long trial and eventually subscribe to cable television after imagining the benefits of cable than after receiving an information packet about cable television (Gregory et al., 1982). Analogous results were obtained when participants were asked to imagine being involved in a car accident (Gregory, Burroughs, & Ainslie, 1985). When later contacted by a 'consumer advocacy group' supposedly conducting a telephone survey, these participants indicated greater agreement with a number of traffic safety items than did control participants who had imagined irrelevant scenarios. Similarly, Mickel (1998) tested whether imagination could increase self-report estimates of healthy behaviour. In this study, participants were encouraged to imagine incorporating three specific healthy behaviours (i.e. drinking water, eating vegetables with dinner, and flossing) into their daily routines. Mickel found that people who imagined drinking water and flossing teeth reported increases in these behaviours. In addition, the investigators found that when the number of imaginings increased so did the estimates of performance.

MEMORY

Research has demonstrated that similarity between actual and imagined events will influence behavioural outcome. For example, plausibility (Anderson, 1983), and self

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relevance (Gregory et al., 1982, Experiment 4) of imagined scenarios have been shown to affect objective and subjective measures of behaviour. Unfortunately, those aspects of imagination that have been demonstrated to be important for behaviour change are the same as those that have been shown to lead to dramatic distortions in memory. As one example, Hyman and Pentland (1996) demonstrated that participants who imagined spilling a punch bowl at a wedding were significantly more likely to recall this fictitious event as compared to a control group. On the other hand, research has also demonstrated that imagination is less likely to lead to memory distortion if the imagined event is implausible (Pezdek, Finger, & Hodge 1997). Pezdek et al. suggested that false memory creation may be dependant on pre-existing scripts or schemas.

Numerous studies have shown that perceptual and contextual similarity between experienced and imagined events may result in source monitoring errors, where people erroneously claim that an imagined event was actually perceived or performed (Johnson et al., 1993). For example, when participants heard words in the experimenter's voice and imagined words in that same voice, they were more likely to think that the imagined words were heard then if they had imagined those words in their own voice (Johnson, Foley, & Leach, 1988). That is, when the imagined and heard words were perceptually similar, errors in source memory were more likely. According to the source monitoring framework (Johnson et al., 1993), memories from different sources (i.e. perceived or imagined) normally differ in their average qualitative characteristics. These typical differences can be used to judge the source of memory. Interestingly, the components of scenarios that have facilitated the largest self-report behavioural changes are the same components that lead to similarity between qualitative characteristics associated with perceived and imagined events. For example, the more plausible the imagined scenario, the more likely changes in reported behaviour will result; however, the more plausible the imagined scenario, the more likely errors in memory will result. The possible confusions in memory that result from similarity between qualitative characteristics lead one to question whether people can assess changes in their own behaviour after having engaged in imagination techniques designed to elicit those changes.

THE PRESENT STUDY

Previous studies have found that imagination can affect both actual (Gregory et al., 1982,1985; Leventhal & Cleary, 1980; Marlatt & Nathan, 1978; Meichenbaum & Goodman, 1971) and self-reported behaviour (Anderson, 1983; Mickel, 1998); however, studies have also demonstrated that imagination can lead to errors in memory (Garry, Manning, Loftus, & Sherman, 1996; Goff & Roediger, 1998; Thomas & Loftus, 2002; Thomas, Bulevich, & Loftus, 2003). The primary motivation for the present set of experiments was to determine whether memory distortion accompanies reported behavioural changes subsequent to guided imagination. Further, these experiments examine whether reported behaviour change can be observed in the absence of memory distortion. As Gregory et al. (1982) have demonstrated, the more self-relevant the imagined scenarios the more likely a change in observed behaviour. However, the question left unanswered by this important study is whether it is the act of imagination or the use of self-relevant information that facilitates behaviour change. Experiment 2 was designed to address this question, and to examine how imagination of self-relevant information and non-self-relevant information affects memory for behaviour.

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In two experiments, behaviour change and memory distortion was measured through self-report. Estimates of caffeinated soft drink consumption were collected prior to and after various imagination manipulations. In addition, during the same session that final estimates of behaviour were collected, participants were asked to recall the estimates they provided at the beginning of the experiment. This task served as an indicator of whether memory for original behaviour had been distorted through the imagination manipulations. Caffeinated soft drink consumption was chosen because, to date, research has not provided conclusive evidence that caffeine consumption poses substantial health risks, but a recent review (Papaioannou, Karatzi, Karatzis, Papmicheal, & Lekakis, 2005) suggests that caffeine exerts acute effects on arterial stiffness and aortic blood pressures. These, in turn, have been linked to the likelihood of developing cardiovascular disease. The authors of this review recommend that serious consideration be given to strategies that may curb dietary caffeine consumption, and it is in this spirit that we have explored whether caffeinated soft drink consumption can be reduced when participants are asked to imagine replacing caffeinated soft drinks with some caffeine-free alternative.

EXPERIMENT 1

Experiment 1 was designed to examine whether imagining drinking an alternative to caffeinated soft drinks could change participants' self-reported consumption of caffeinated soft drinks. Experiment 1 was also designed to determine whether in addition to changes in self-reported consumption, we might find changes in memory of performance. Therefore, participants were asked at the end of the study to recall their original estimates of behaviour. In this experiment, a simple imagination script that was rated as highly plausible and only moderately self-relevant, but contained limited explicit sensory and perceptual cues, was used. Thus, we designed an imaginary scenario that, based on previous literature, would likely lead to changes in estimates of behaviour, while attempting to minimise as best as we could changes in memory for behaviour.

Methods

Participants

Pre-test questionnaires were completed by approximately 800 students at the University of Washington and 100 students at Washington University. By having a large number of people complete this questionnaire, we expected to be able to select a reasonable sample that satisfied the criteria for the experiment. Based on their responses, 272 students from the University of Washington and 50 students from Washington University were eligible to participate in the experiment and were contacted by an experimenter. Fourty-eight participants completed all 3 experimental sessions, 32 from the University of Washington and 16 from Washington University.

Materials and procedure

All of the students in the pre-test session completed a 30-item health habits questionnaire (HHQ) (Mickel, 1998) designed to elicit estimates of the frequency with which they performed a variety of health-related behaviours in the past week and on average per week. Participants answered questions about nutrition, sleep, smoking, alcohol consumption and caffeine consumption. Only those students whose estimated behaviour fell between 5 and

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15 in response to the following two questions were contacted to participate in the experiment:

'In the past week, how many caffeinated soft drinks have you had'?

'On average, how many times per week do you have a caffeinated soft drink'?

We chose five as the lower range so that participants in the study would have room to reduce reported consumption. Fifteen was used to cap the range to avoid using people with extreme scores. In addition, participants were not contacted if they indicated consumption of other types of caffeinated beverages. Therefore, coffee and tea drinkers were not included in this study. Those participants whose responses were consistent with these criteria for inclusion were contacted via telephone and asked to participate in an experiment designed to study imagination. At this point, participants were not told that this 'imagination' study was related to the questionnaire they completed during the mass testing session. Deception was used to mask the relationship between the questionnaire and the imagery techniques to be employed in order to reduce the effects of demand characteristics on the results. Participants were contacted by an experimenter who was unfamiliar to them and were tested in a room different from the one in which mass testing took place.

Session 2 was conducted 2 weeks after mass testing. At the beginning of this session, participants were told that this was an experiment designed to investigate the effectiveness of different types of imagination scripts on engendering vivid, realistic mental images. This cover story was used to reduce demand characteristics by making the imagination sessions seem as though they were completely unrelated to estimates of behavioural performance provided on the HHQ. That is, participants were led to believe that the imagination sessions and the questionnaire sessions were parts of completely different experiments.

Participants were randomly assigned to one of two conditions. One group received an imagination script that dealt with the reduction of caffeinated soft drink consumption, while the other group served as a control and received an imagination script that dealt with reduction of smoking.[1] The participants in the caffeine imagination condition consisted of 17 students from the University of Washington and 10 students from Washington University. The participants in the smoking control imagination condition consisted of 15 students from the University of Washington and 6 students from Washington University. Participants in the caffeine condition received the following imagination scenario:

'Imagine replacing your caffeinated soft drink with a caffeine-free alternative (fruit juice, water, milk. . .) at mealtime and/or while snacking as part of your daily routine'.

Participants in the control group received the following imagination scenario:

'Imagine replacing your cigarette with an alternative (gum, candy, etc. . .) after a meal or while on a break as part of your daily routine'.

[1]The imagination scripts were rated separately for plausibility and self-relevance by a group of 42 Washington University undergraduates. Specifically, students were asked to read each script and provide a response to the question, 'How plausible is the following scenario'? using a 7-point likert scale where one was 'not plausible at all' and 7 was 'extremely plausible'. The average plausibility rating for the caffeine scenario was 6.2 ($SD = 0.6$); the average plausibility rating for the smoking scenario was 6.7 ($SD = 1.1$). Students were also asked to rate the self-relevance of each script using the same scale. Specifically, students were asked: 'How likely are you to think of yourself in the following scenario'? The average self-relevance rating for the caffeine scenario was 4.8 ($SD = 1.2$); the average self-relevance rating for the smoking scenario was 5.4 ($SD = 1.5$).

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Experimental packets were distributed that contained two imagination scripts and a filler questionnaire. Groups of participants assigned to the respective experimental conditions were tested separately. The target imagination script appeared on the first page of the experimental packet, and participants followed along as the experimenter read this script aloud. Participants were then told to create images that were as complete and as clear as possible. Participants were carefully instructed as to how to generate images. Specifically, they were told to close their eyes and generate a detailed image that included perceptual details such as colour, sound, etc. The instructions did not differ between the two groups of participants. Review of instructions by the experimenter took approximately 10 minutes with time for questions. Consistent with the work conducted by Mickel (1998), participants were given 20 seconds to form an image based on the scenario that was read to them. Several experiments investigating the effect of imagination on memory have provided participants with a comparable amount of time, approximately 15 seconds, to imagine a short scenario (see Goff & Roediger, 1998; Thomas & Loftus, 2002, Thomas et al., 2003).

After having performed the first imagination task, participants rated the vividness of their generated image on a Likert scale of 1 through 5 and then completed the *Change Seekers Index* developed by Garlington and Shimota (1964). Responses provided on this questionnaire will not be discussed as it was merely a filler task. Participants were given 10 minutes to complete the *Change Seekers Index* and then the second imagination script was read to them and they were instructed to imagine a scenario consistent with that script. The second imagination scenario (smoking reduction) was included to further reduce demand characteristics. Participants in the control condition were given smoking imagination scripts before and after the *Change Seekers Index*. No other behavioural assessments were taken during the imagination session.

Session 3 occurred 1 week after Session 2 and was identical to Session 2. Session 4 took place 2 weeks after Session 3. Prior to session 4, participants who had completed the 'imagination' experiment (Sessions 2 and 3) were contacted by yet another experimenter and asked whether they would be interested in participating in a 'health behaviour' experiment that involved completing a questionnaire related to their health habits. Again, no mention was made regarding the mass testing session and the 'imagination' experiment was not referenced. In Session 4, all participants completed a second HHQ and were given a follow up questionnaire that assessed memory for the estimates they had provided on the first HHQ administered 5 weeks earlier.

Results

In order to determine whether participants were aware of the relationship between the HHQ and the imagination sessions, participants indicated what they believed was the true purpose of the study. Just 2 of 48 participants indicated that the 'questionnaire study' and the 'imagination study' must somehow be related. Further, both of those participants were in the control condition of the experiment. Of those remaining, 36 felt the imagination experiment was designed to investigate mental imagery, 9 thought it was linked to different experiments being conducted at the same time (but unrelated to the present study) and 1 participant thought it was designed to help him quit smoking. Thus, the majority of participants seemed unaware of the link between the imagination sessions and their responses to questions targeting caffeinated soft drink consumption on the HHQ.

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Table 1. Average self-report behaviour assessment and memory for original assessment of caffeinated soft drink consumption

	1st		2nd		Memory for 1st	
	M	SE	M	SE	M	SE
Experiment 1						
Caffeine imagination	9.0	0.6	4.9	0.6	6.2	0.5
Smoking imagination	8.5	0.4	8.0	0.4	8.7	0.6
Experiment 2						
Self-relevant imagination	11.1	0.5	5.4	0.5	4.9	0.4
Non-self-relevant imagination	11.0	0.4	10.0	0.5	8.0	0.7
Self-relevant information	10.0	0.5	7.0	0.5	10.2	0.6
Non-self-relevant information	11.2	0.4	11.0	0.5	9.6	0.5

Self-report behaviour change (HHQ1 and HHQ2)

As can be seen in Table 1, participants assigned to the caffeine imagination condition ($M = 9.0$, $se = 0.6$) indicated similar average week consumption on the first HHQ as those assigned to the smoking control condition ($M = 8.5$, $se = 0.4$). When compared statistically, the two groups did not differ, $t < 1$. However, after the imagination session, those who imagined the caffeine reduction scenario indicated that on average they drank fewer caffeinated soft drinks ($M = 4.9$, $se = 0.6$) than those who imagined the smoking reduction scenario ($M = 8.0$, $se = 0.8$). To analyse these results, a 2 (questionnaire: 1st HHQ, 2nd HHQ)$\times$2 (imagination: caffeine, smoking control) ANOVA was performed on the average week estimates of soft drink consumption. All p-values are less than 0.05 unless otherwise stated. To begin with, participants' estimates on the first HHQ ($M = 8.8$) were significantly higher than estimates made on the second HHQ ($M = 6.5$), $F(1, 46) = 33.1$, $MSe = 3.9$. Further, a main effect for imagination condition was found, $F(1,46) = 4.7$, $MSe = 7.9$, indicating that participants who were given the caffeine scenario ($M = 6.9$) provided post-imagination estimates that were significantly lower than those who were given the smoking scenario ($M = 8.3$). More importantly, however, the interaction between questionnaire and imagination condition was significant, $F(1,46) = 19.5$, $MSe = 3.9$. This finding demonstrates that at the beginning of the experiment, when participants were given the first HHQ both groups of participants provided statistically equivalent estimates; however, after imagination, participants assigned to the caffeine imagination condition provided significantly lower estimates of consumption than those assigned to the smoking imagination condition.

While the caffeine imagination condition produced significantly greater decreases in estimates of caffeine consumption, these results do not definitively show that behaviour was actually affected by the caffeine scenario. Rather, people who imagined not drinking caffeinated soft drinks may have only believed that they were drinking fewer soft drinks on average than those who engaged in the smoking imagination. This belief may stem from a distortion in memory produced by imagination.

Memory change (HHQ1 and memory assessment)

To assess whether the imagination sessions altered memory for behaviour we asked participants to provide their original estimates of caffeinated soft drink consumption after

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completing the second HHQ. That is, participants were asked to remember what they had indicated as their average week consumption during the mass testing session. As can be seen in Table 1, participants in the caffeine condition were far more likely to misremember their originally reported consumption ($M = 6.2$, $se = 0.5$) than participants in the smoking condition ($M = 8.7$, $se = 0.6$). To analyse these results statistically, a 2 (original consumption: HHQ1, memory assessment) $\times$ 2 (imagination: caffeine, smoking) ANOVA was performed on the average week estimates. A main effect of reported consumption was found, $F(1,46) = 22.3$, $MSe = 1.9$, indicating that estimates of consumption differed between HHQ1 ($M = 8.8$) and the memory assessment ($M = 7.5$). Further, the interaction between original consumption estimates and the imagination condition was also significant, $F(1,46) = 28.1$, $MSe = 10.3$, supporting the conclusion that participants who received the caffeine reduction imagination script were more likely to misremember their original estimates than participants who were given the smoking scenario.[2]

Discussion

The motivation of this first experiment was to determine whether a short, plausible, moderately self-relevant imagination script could yield changes in reported caffeinated soft drink consumption. In addition, we examined whether changes in *memory* for the target behaviour would be affected by the imagination sessions. To begin with, we found that participants, who imagined a short caffeine-reducing scenario for only 20 seconds over two sessions, indicated that they drank fewer caffeinated soft drinks at the end of the study. These results are consistent with previous findings that have demonstrated the powerful effects of imagination on behaviour (i.e. Gregory et al., 1982) and attitudes (i.e. Gregory et al., 1985), and demonstrate that a change in self-reported behaviour can be found even when participants are given a very small window in which to imagine the scenario. While a change in reported behaviour was found, it is important to note that actual behaviour was not measured directly.

It is unlikely that this change in behavioural estimates was due to demand characteristics. In an attempt to minimise the contribution of perceived experimenter demands, we led participants to believe that they were involved in two distinct experiments—a 'health behaviour' experiment and a 'guided imagery' experiment. Use of deception was warranted because participants may have intuited our interest in eliciting reductions in caffeinated soft drink consumption and merely felt obligated to comply if we had not convinced them that the two studies were unrelated (Orne, 1962). Only two participants indicated in a post-test questionnaire that they believed the 'questionnaire' study and 'imagination' study were somehow linked.

[2]While participants were asked two questions related to caffeinated soft drink consumption, the pattern of data did not differ between the two questions. Specifically, we compared *average week* and *past week* estimates made during the initial completion of the HHQ, and found no significant difference, $t < 1$. That is, when first asked to report *average week* and *past week* estimates, participants provided statistically identical estimates. Similar comparisons between *average week* and *pastweek* estimates were made for the second HHQ, and again, no significant differences between these estimates were found, $t < 1$. Finally, the pattern of underestimation as a function of Session 2 activity was similar for *past week* and *average week* estimates. These comparisons led us to the conclusion that the participants did not differentiate between the *average week* and *past week* estimates, treating these questions as the same. Because of this and in the interest of brevity and clarity, our analysis focuses on answers given before and after the imagination sessions to the question: 'On average, how many times per week do you have caffeinated soft drinks'?

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While demand may not have been the incentive for change in reported caffeinated soft drink consumption, the results from Experiment 1 suggest that reported behaviour change may not reflect true behaviour change, but rather a change in memory for behaviour. When asked to recall their originally reported consumption of caffeinated soft drinks, participants in the caffeine imagination condition were more likely to erroneously reduce their original estimates than those who were given the smoking reduction imagination scenario. Indeed, the remembered estimates provided by participants in the control condition were no different from the actual estimates they had provided at the outset of the investigation. One possible explanation for why participants in the caffeine imagination condition reported drinking fewer beverages is that imagination may have distorted memory for the behaviour. This point and additional explanations will be discussed further in the general discussion.

The inability to correctly report behaviour after imagination has direct implications for using self-report measures in research. Self-report assessments of behaviour are regularly used both in psychological and epidemiological studies. Experiment 1 calls into question the accuracy of these subjective measures. Experiment 2 was designed to further examine the effects of imagination on memory for behaviour and assess the components of imagined scenarios that yield the greatest errors in memory for self-report assessment of behaviour.

EXPERIMENT 2

Experiment 2 was designed to determine whether imagination and self-relevance interact to affect memory for behaviour. According to Gregory et al. (1982), imagination is the key factor leading to behaviour change in these paradigms; however, in many of these studies, participants imagined self-relevant scenarios and those conditions were compared to ones in which information was presented in a non-self-relevant manner. When 'others' have been used as the main characters in imagined scenarios (i.e. Anderson, 1983), non-imagined conditions were not included. Experiment 2 bridges this gap and examines whether memory distortions as a result of imagination can be reduced when personal reference is manipulated.

Method

Participants

Pre-test questionnaires were completed by 402 students at Washington University. Based on their responses, those eligible to participate in the experiment were contacted. Two hundred twenty students were eligible to participate and 144 students completed all 4 sessions of this experiment.

Materials and procedure

The HHQ and the selection criteria that were used in the first experiment were also used here. Participants returned approximately 2 weeks after having completed the HHQ to participate in Session 2 and the relationship between the completion of the HHQ and the imagination sessions was masked using the technique that was applied in Experiment 1. In Experiment 2, participants were divided into four groups. The self-relevant nature of the scenario and whether the scenario was imagined or simply read were manipulated such that participants imagined a self-relevant scenario, read a self-relevant scenario, imagined a

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non-self-relevant scenario or read a non-self-relevant scenario. Included in the Appendix are the scenarios used in all four conditions.[3]

The procedure used in Session 2 was similar to that used in Experiment 1. As indicated above, participants either imagined the aforementioned scenario or read the information provided in that scenario. Participants were given 20 seconds to either imagine or read the scenario. Participants instructed to imagine the scenario were given the same imagery instructions used in Experiment 1. After imagination, participants rated the vividness of the imagination on a 7-point Likert scake. Participants instructed to read the scenario were simply told to read the script in order to make an evaluation of message effectiveness. After reading the script, participants rated how effective they thought the script would be in influencing readers on a 7-point Likert scale where 1 was 'not effective' and 7 was 'extremely effective'. After having completed the target 'imagination' or 'read' task, participants completed the *Change Seekers Questionnaire*, and were presented with a second filler scenario that focused on the reduction of smoking. Each group was given information to read that focused on the consequences of smoking.

Session 3 occurred 1 week after Session 2, and was identical to that session in all respects. Session 4 took place 2 weeks after Session 3 and was identical to Session 4 in Experiment 1. Again steps were taken to minimise potential awareness of the relationship between the imagination sessions and the questionnaire sessions. Participants completed a second HHQ and were given a follow-up questionnaire that assessed memory for the estimates they had provided on the first HHQ administered 5 weeks earlier.

Results

As in Experiment 1, at the end of their participation in all of the sessions, participants were asked to indicate what they believed was the true purpose of the study. Twelve of the 144 participants indicated that the 'questionnaire study' and the 'imagination study' must somehow be related. Two of these participants were in the self-relevant imagination condition, eight were in the non self-relevant information condition, and two were in the non self-relevant imagination condition. As with Experiment 1, these findings suggest that the majority of participants were unaware of the link between the imagination sessions and their responses to questions targeting caffeinated soft drink consumption on the HHQ.

Self-report behaviour change (HHQ1 and HHQ2)

As can be seen in Table 1, regardless of condition, the average week consumption of caffeinated soft drinks was statistically identical on the first HHQ, $F < 1$. However, changes in self-reported caffeinated soft drink consumption were affected by whether or not participants engaged in imagination and by the self-relevant nature of the scenario. At the end of the study those who engaged in self-relevant imagination ($M = 5.4$) showed the

[3]Plausibility and self-relevance were rated by a separate group of 100 Washington University undergraduates. On a scale of one through seven where one was 'not plausible at all' and seven was 'extremely plausible', students indicated the plausibility for each scenario: self-relevant imagination, $M = 6.2$; non-self-relevant imagination, $M = 5.9$; self-relevant information, $M = 6.5$; non-self-relevant information, $M = 6.0$). No statistical difference was found among these four conditions, $F < 1$. Self relevance was also rated on a similar Likert scale where one was 'not self-relevant' and seven was 'extremely self-relevant'. As we expected, participants rated the scenarios that were designed to be self-relevant as more self-relevant than those that were not designed as such (self-relevant imagination, $M = 5.1$; non-self-relevant imagination, $M = 2.6$; self-relevant information, $M = 5.0$; non-self-relevant information, $M = 2.2$). A t-test comparing the self-relevant scenarios to the non self-relevant scenarios found a significant different, $t(99) = 18.2$, $Se = 0.14$.

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greatest change in reported caffeinated soft drink consumption. In fact, as Table 1 illustrates, self-relevance played a greater role in reported caffeinated soft drink consumption than imagination. If the scenario was not self-referent, participants were unlikely to indicate that their caffeinated soft drink consumption had changed regardless of whether the scenario was read or imagined. To analyse these results, a 2 (questionnaire: 1st HHQ, 2nd HHQ)×2 (imagination: imagined, read) ×2 (self-relevance: self-relevant, non self-relevant) ANOVA was performed on average estimates of soft drink consumption. As in Experiment 1, *p*-values are less than 0.05 unless otherwise stated.

To begin with, participants' estimates on the first HHQ ($M = 10.8$, $se = 0.4$) were significantly higher than estimates made on the second HHQ ($M = 8.4$, $se = 0.5$), $F(1, 140) = 83.4$, $MSe = 5.9$. Further, a main effect for self-relevance was also found, $F(1, 140) = 31.9$, $MSe = 10.5$. Participants who were presented with self-relevant scenarios produced smaller estimates of behaviour ($M = 8.5$, $se = 0.4$) as compared to participants who were presented with non self-relevant scenarios ($M = 10.5$, $se = 0.3$). Interestingly, the difference between scenarios that were imagined and were not imagined was not significant, $F < 1$. However, the interaction between questionnaire and imagination was significant, $F(1,140) = 5.66$, $MSe = 5.9$. As Table 1 illustrates, participants who engaged in non self-relevant imagination were unlikely to change their estimates of average week consumption ($M = 10.0$); however, participants who engaged in self-relevant imagination produced significantly lower estimates of consumption after the imagination intervention ($M = 5.4$). Finally, the interaction between questionnaire and self-relevance was also significant, $F(1,140) = 42.4$, $MSe = 5.9$. This interaction mirrors that between questionnaire and imagination. Specifically, participants who read a self-relevant scenario produced significantly lower estimates of consumption at the end of the experiment ($M = 7.0$) as compared to the beginning of the experiment ($M = 10.0$). On the other hand, participants who read a non self-relevant scenario did not change their estimates of average week consumption. The interaction between imagination and self-relevance was not significant, $F < 1$.

Memory change (HHQ1 and memory assessment)

To assess whether the imagination sessions altered memory for behaviour, we asked participants to provide their original estimates of caffeinated soft drink consumption after they completed the second HHQ. As can be seen in Table 1, memory for the original estimates of consumption was greatly impaired in the self-relevant imagination condition ($M = 4.9$, $se = 0.4$). To analyse these results, a 2 (questionnaire: 1st HHQ, 2nd HHQ)×2 (imagination: imagined, read) ×2 (self-relevance: self-relevant, non self-relevant) ANOVA was performed on average estimates of behaviour made at the beginning of the experiment, and memory for those estimates. A main effect for consumption report was found, $F(1, 140) = 83.6$, $MSe = 6.2$, indicating that participant's estimates of consumption differed between HHQ1 ($M = 10.8$, $se = 0.3$) and the memory assessment ($M = 8.2$, $se = 0.5$). A main effect for imagination was also found, $F(1, 140) = 10.91$, $MSe = 16.8$. Participants who read information produced higher estimates of behaviour on HHQ1 and memory for HHQ1 ($M = 10.3$, $se = 0.5$), as compared to participants who imagined scenarios ($M = 8.8$, $se = 0.5$). In addition, the interaction between questionnaire and imagination was also significant, $F(1, 140) = 37.3$, $MSe = 6.2$. Participants who engaged in self-relevant imagination were more likely to misremember their original reports of average week caffeine consumption at the end of the experiment ($M = 4.9$) as compared to participants who engaged in non self-relevant imagination ($M = 8.0$). Finally, the three-way

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interaction between questionnaire, imagination and self-relevant was also significant, $F(1,140) = 15.8$, $MSe = 6.2$. This interaction demonstrates that estimates of behaviour at the beginning of the experiment and memory for those estimates only differed when participants engaged in self-relevant imagination. In all other conditions, similar reports of pre-experimental consumption and memory for that consumption at the end of the experiment were found. There were no other significant main effects or interactions, $F < 1$.

Discussion

Consistent with previous research examining imagination's effects on memory, this study has demonstrated that imagining a behaviour either with oneself or another person as the main character will result in errors in memory; however, these errors were greatly reduced when participants imagined another person as the main character in the scenario. When participants imagined another person as the main character no effect on self-reported behaviour was found, demonstrating the lack of utility of using this condition to change reported behaviour. Critically, one condition did elicit changes in self-reported behaviour without influencing memory for the original estimates of behavioural performance. When participants were given self-relevant information, they reported that they drank fewer caffeinated soft drinks at the end of the experiment (7.0), and their memory for their original estimates of consumption was accurate (HHQ1 $M = 10.0$; Memory for HHQ1 $M = 10.2$). These results suggest that providing people with self-relevant scripts may be more useful in behavioural modification than guided imagination because people are able to accurately remember prior behavioural patterns.

GENERAL DISCUSSION

In both experiments, we found that when participants imagined themselves not drinking caffeinated soft drinks, they reduced estimates of average week consumption between HHQ1 and HHQ2. This series of experiments extends previous work which has shown that imagination can be enlisted to *increase* the likelihood of a particular behaviour (i.e. Gregory et al., 1982) by demonstrating that this technique can also be used to *decrease* the likelihood of negative behaviours. While decreases in reported consumption were found, it is important to acknowledge that the behaviour change assessed in this study was based on self-report—we relied on the accuracy of participants' introspections about past caffeinated soft drink consumption to determine whether or not their behaviour had been modified. Therefore, the reduction in estimates of average week consumption may not definitively indicate that actual behaviour had changed. Changes in estimates of average week consumption between HHQ1 and HHQ2 may have been influenced by several factors: demand characteristics, simply completing a second HHQ, average misremembrance of past behaviours, increased vigilance of the target behaviour over the course of the experiment, any act of imagination and/or source monitoring errors. We will discuss the influence of each of the factors individually.

Changes in reported behaviour (HHQ1 to HHQ2)

Let us first address the issue of demand. We are confident that demand characteristics cannot account for changes in estimates of behaviour as measures were taken to ensure that

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participants were not aware of the relationship between the questionnaire and imagination sessions. Still, dramatic changes in reported behaviour (as assessed by HHQ1 and HHQ2) were found. If not demand, then possibly completing a second HHQ outside of any other experimental manipulation may have yielded the changes in reported consumption found in Experiments 1 and 2. While this possibility exists, the estimates of caffeinated soft drink consumption gathered from participants in the smoking control condition suggest that the experimental manipulation of imagination did have an effect on estimates of reported consumption made on HHQ2. Specifically, participants in the smoking control condition, like participants in the imagination conditions, completed an HHQ during Session 1, and a second HHQ during session 4, yet the results of Experiment 1 clearly demonstrate an underestimation of original reports of caffeine consumption only in the group who imagined replacing caffeinated soft drinks with an alternative. Thus, it seems unlikely that simply completing the second HHQ influenced reports of memory for the first HHQ.

Another potential explanation for the present findings is that in the present study, we assume that outside of experimental manipulation, people can accurately remember their past behaviours. However, research has demonstrated that under a variety of circumstances people often misremember their past (Abelson, Loftus, & Greenwald, 1992). Memory accuracy for past behaviours can be influenced by the frequency of behaviours (Blair & Burton, 1987), and regularity of occurrence (Menon, 1997). Research suggests that frequent, non-distinctive, irregularly occurring events are more likely to yield behaviour reporting errors (Belli, Schwarz, Singer, & Talarico, 2000). Caffeinated soft-drink consumption is a frequent, non-distinct, irregularly occurring event, and therefore, behaviour estimates on HHQ1 and HHQ2 may have been inaccurate. The present methodology does not allow for us to differentiate between the inaccuracies in reporting of behaviour due to misremembering the past versus changes in behavioural estimates due to experimental manipulations, such as imagination. However, while participants may have erroneously reported behavioural estimates on HHQ1 and HHQ2, the present findings demonstrate a consistency in reporting on HHQ1 across all experimental groups, and systematic changes in reporting on HHQ2 and in memory for HHQ1 that correspond to experimental manipulations.

A fourth explanation for the changes in behavioural estimates on HHQ2 is that imagination (or reading) in the intervening sessions may have led to increases in accuracy on the second HHQ because participants may have become more vigilant in tracking their caffeinated soft drink consumption. In addition, behavioural estimates on HHQ1 may have been erroneously high, because of a lack of vigilance of the behaviour in question at the time of completion of the questionnaire. While a possibility, the results of Experiment 2 would suggest that additional processes are affecting estimates of behaviour on HHQ2. Specifically, in Experiment 2, estimates of behaviour on HHQ2 were modulated by self-relevance of scenarios, but memory for behaviour (as assessed by the final memory question) was impaired only for participants who *imagined* self-relevant scenarios. Thus, experimental manipulations indeed made participants more accurate, this accuracy was only demonstrated in conditions where participants *read* self-relevant scenarios. Imagination of those same scenarios produced a different pattern of results.

A fifth explanation for the present data is that the act of imagination, regardless of the type of imagination (related vs. unrelated to target behaviour), may have yielded the revealed changes in behavioural estimates. However, the smoking control condition, one in which participants imagined a behaviour, did not lead to changes in behaviour estimates, and participants in the condition were able to accurately recall original estimates.

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Similarly, participants who did imagine non self-relevant scenarios did not change estimates of behaviour between HHQ1 and HHQ2. These results would suggest that mere imagination alone did not lead to changes in behavioural estimates; rather, imagination that was targeted to the behaviour in question and that was also self-relevant facilitated changes in behavioural estimates.

Using memory for behaviour to explain changes in estimates of behaviour

We have reviewed several explanations that could possibly account for changes in behavioural estimates between HHQ1 and HHQ2; however, none of these explanations completely account for the present pattern of data. In order to devise a compelling explanation for the present results, we turn to assessments of memory. Recall that in both experiments participants were asked to report their original estimates of consumption, thereby providing a memory assessment of information provided on HHQ1. This memory assessment was introduced to determine whether certain experimental manipulations had a disproportionate effect on memory for past events. At the end of these experiments, participants were simply told to think back and try to remember their original estimates of caffeinated soft drink consumption. When participants were asked to recall their original estimates, memory was distorted in the downward direction, and that distortion was greatest when participants engaged in self-relevant imagination. Experiment 2 demonstrated that while imagination led to the greatest reported behaviour change, reading a scenario that outlined the negative outcomes of caffeine consumption also led to a significant reduction in reported consumption, provided the scenario was self-relevant. Critically, it was under these circumstances that the reduction in self-reported consumption did not accompany memory distortion for the original estimates. Those distortions were only found in conditions in which participants engaged in imagination.

The results of these experiments show that participants who engaged in self-relevant caffeine reducing imagination were more likely to misremember their original estimate of consumption as compared to participants who read similar scripts or who imagined an unrelated behaviour (i.e. reduction of smoking). One interpretation of these findings is that imagination of a self-relevant behaviour may have distorted memory for that originally reported behaviour, and this distortion may have contributed to behaviour estimates made on the HHQ2.

The source-monitoring framework has often been used to account for a wide variety of memory distortions, and pertinent to the present study, distortions as a result of imagination (Goff & Roediger, 1998; Libby, 2003; Thomas et al., 2003). According to the source-monitoring framework, thoughts, images and feelings that are experienced as memories are attributed to particular sources of past experiences (Lindsay & Johnson, 2000). The assessment of these and other qualitative characteristics, such as the amount and quality of sensory information (e.g. colour and sound), contextual information (time and place), semantic detail and cognitive operations, allow one to determine the credibility of a memory (Johnson et al., 1993; Johnson & Raye, 1981). Experiment 2 demonstrated an additional contextual cue that people use to distinguish between real and imagined events. The contribution of self-relevant information to obscuring memory for behaviour had not previously been investigated, and the results of Experiment 2 demonstrated that self-relevant information, when included in the act of imagining, may serve to obscure source memory. Participants who were given a self-relevant imagination scenario were far more likely to misremember their original estimates of behaviour than participants who were given a non self-relevant imagination scenario.

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Source misattribution occurs when perceptual and contextual cues are not well encoded, or when the cues associated with two or more sources are, or become, similar. A variety of conditions will facilitate the confusion between imagined and perceived memories. For example, the passage of time (Johnson, Kounios, & Reeder, 1994), elaboration of imagination (Thomas et al., 2003) and repetition of imagination (Goff & Roediger, 1998; Thomas & Loftus, 2002; Thomas et al., 2003; Thomas & Bulevich, 2005) are techniques that have been used to blur the line between real and imagined memories. We employed all three of these techniques, in addition to manipulating self-relevance, in the present study; some, if not all, may have served to obscure the distinction between what actually happened and what was only imagined.

Finally, we must acknowledge the role that idiosyncratic implicit theories play in the reconstruction of personal histories. Ross (1989) suggested that people possess implicit theories regarding the inherent consistency of their attributes and that people use these theories to construct personal histories. Implicit theories are schema-like knowledge structures that include specific beliefs regarding the inherent stability of an attribute, as well as a set of general principles concerning the conditions likely to promote personal change or stability. These theories are implicit in that they encompass rarely discussed but strongly held beliefs. Implicit theories may affect memory by influencing the kind of information retrieved from memory as well as the individual's understanding of that retrieved information. Memories consistent with a person's belief are often more accessible than memories inconsistent with beliefs. Thus, if an individual believes that he should drink fewer caffeinated soft drinks, then that individual may access memories in which he specifically chose to not drink caffeinated soft drinks. In essence, an implicit theory may serve to organise memories into a coherent pattern of information that is consonant with the personal beliefs regardless of accuracy.

One important implicit theory stresses the unity and stability of self (James, 1890). When this consistency theory is invoked, people view their current standing on an attribute or behaviour as an accurate reflection of their past status. Consequently, if individuals adopt a theory of consistency in the face of actual change, they may exaggerate the similarity of the past to the present. The findings of the present work suggest that memory misattributions, as a result of imagination, may interact with implicit theories of consistency to produce the reported behaviour change and the associated memory errors. The findings of Experiment 2 are particularly important for understanding the nature of the interaction between implicit theories and memory attributions. Specifically, in the self-relevant information condition of Experiment 2, we found a decrease in reported caffeinated soft drink consumption, without the associated memory error for original consumption. That is, the majority of participants in this condition accurately remember their past statements. Participants may have been less likely to adopt a theory of consistency in the face of actual change because the condition of reading but not imagining the caffeine reduction scenario decreased the chances for memory misattributions based on perceptual and contextual cue overlap.

CONCLUSIONS

Imagination is indeed a powerful tool. Even when people are not particularly motivated to change behaviour, imagination does lead to reported behaviour change. In the present study, we have provided an empirical example demonstrating how imagination may

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possibly lead people to engage in healthier behaviour. Specifically, participants imagined an alternative to caffeinated beverages, and they subsequently reported lower consumption. This is a good thing. However, if imagination is to be used to change behaviour, one must be cautious. Results from this study suggest that after imagination has taken place, memory for originally reported behaviour is impaired. This is a potential negative 'side effect' of imagination.

In both experiments, we found that estimates of pre-manipulation behaviour were lower, and thus, less accurate. These inaccuracies may not harm the individual imager directly, but indirect 'societal harm' may result. Suppose a group of participants whose behaviour had been altered through imagination were to participate in an epidemiological study designed to explore the effects of food history on health. These participants, in estimating their history, would provide distorted estimates, thus impairing the ability of the epidemiologist to draw accurate inferences about the relationship between food history and health. The impairment in memory found in this study may be due to an interaction between implicit theories of consistency and memory misattributions.

Discovering mental manipulations that would lead to healthier behaviours in an individual while simultaneously not producing the problematic side effect of memory distortion would obviously be beneficial. Our research shows that this may indeed be possible if the right mental manipulations are empirically tested. Additionally, this work represents an important first step as it suggests that self-relevance can be harmful or helpful depending upon the context in which it is encountered (imagined vs. read). The results from this study demonstrate that researchers and clinicians cannot rely on participants or clients to accurately recall past behaviours or other attributes after self-relevant imagination has been employed. On the basis of these results, one must conclude that imagination is a powerful tool of suggestion that may play a critical role in the representation of one's personal history.

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Appendix

Imagined Self-Relevant Scenario

Take a moment and imagine the consequence of caffeinated soft drink consumption. Imagine after drinking a caffeinated soft drink that your heartbeat, respiration and metabolic rate increase. Imagine the increase in stomach acid and urine. Imagine that when you drink caffeinated soft drinks you become more restless, nauseous, have headaches, tense muscles, sleep disturbances and irregular heartbeats. Now imagine trying to reduce your caffeinated soft drink consumption with a caffeine-free alternative like milk, juice or water.

Imagined Non Self-Relevant Scenario

Take a moment and imagine the consequences of caffeinated soft drink consumption on your best friend. Imagine that after drinking a caffeinated soft drink that your friend complains that his/her heartbeat, respiration and metabolic rate increases. Imagine your friend complains that his/her stomach aches because of acid and imagine he/she frequently has to urinate. Imagine that your friend becomes more restless, nauseous, has headaches, complains of tense muscles, sleep disturbances and irregular heart beats. Now imagine that your friend attempts to reduce his/her caffeinated soft drink consumption with a caffeine-free alternative like milk, juice or water.

Read Self-Relevant Scenario

Caffeinated soft drinks will have consequences for you. Caffeinated soft drinks will increase your heartbeat, respiration and metabolic rate. You will notice an increase in stomach acid and urine. When you drink caffeinated soft drinks, you will become more restless, nauseous, have headaches, tense muscles, sleep disturbances and irregular heart beats. Because of these consequences, it is in your best interest to reduce your caffeinated soft drink consumption with a caffeine-free alternative like milk, juice or water.

Read Non-Self-Relevant Scenario

Caffeinated soft drinks increase heartbeat, respiration, metabolic rate and the production of stomach acid and urine. Too many caffeinated soft drinks can produce restlessness, nausea, headache, tense muscles, sleep disturbances and irregular heartbeats. Many scientists agree that people should only consume approximately one 12 ounce serving of a caffeinated beverage a day. In order to reduce caffeine consumption, scientists suggest replacing your caffeinated beverages with a caffeine-free alternative like milk, juice or water.

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