Effects of Brief Mindfulness Induction on Weakening Habits: Evidence from a Computer Mouse Control Task

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Abstract

Adapting to a new behavior is challenging when previous habits dominate one's behavioral patterns. We examined the effects of a brief six-minute mindfulness induction on the acquisition of a new behavior (moving computer mouse cursor with its direction reversed) and the extent to which it disengaged previous habits (moving computer mouse cursor as per normal). Thirty-one participants were randomly assigned either to experimental or control groups. They were asked to perform a computer-based target clicking task during which mouse direction was normal and reversed for separate sets of trials before and after the manipulation. The 2 (time: pre-test vs. post-test) by 2 (condition: mindfulness induction vs. control condition) mixed ANOVA results showed that there was no significant interaction between time and condition for both old and new behaviors. However, significant interaction between time and condition was found in terms of number of mistakes made while initiating movements for the trials in the normal mouse orientation (old behavior). This finding suggests that a brief mindfulness induction may have weakened existing habits. Future studies could examine the effects of mindfulness induction on real-life tasks where performance measurement is also possible, such as text typing, to see if learning to type on an unfamiliar keyboard weakens existing typing habits after mindfulness induction.

Keywords: habits, state mindfulness, present-moment awareness, habitual responses, weakened association

Introduction

Performing a drastic variation of a well-practiced task, such as driving a car on the side that one is not familiar with, can be challenging. For example, an American driving in the UK for the first time will need to make adjustments in the way he or she operates the right-hand drive car in directionally different traffic conditions. By the same token, even when crossing the road in the UK, the American tourist needs to check for incoming vehicles in a different manner before crossing given the opposite directional convention. Similarly, getting used to a new operating system on a computer or a smartphone also calls for some adaptation. The need for behavioral adjustments occurs in many aspects of daily living; some are drastic and immediate, while others may be more subtle but happen over a longer timeframe. Regardless of the timescale, one is essentially attempting to disengage well-entrenched habits when making those adjustments.

Mindfulness can be briefly defined as bare and nonjudgmental attention and awareness to the present moment (Brown and Ryan 2003). Brown et al. (2007) summarized a few characteristics of mindfulness as follows: clarity, nonconceptual and nondiscriminatory, “empirical stance towards reality” (p. 213), flexibility, present-oriented, and stability of consciousness. When one is in a mindful state, there is a sense of clarity in one’s awareness as to what is happening both internally (i.e., sensations, thoughts, emotions) and externally (i.e., surroundings, actions) at that particular moment. Such clarity of awareness is also nonconceptual and nondiscriminatory in nature, whereby the internal and external registered inputs are experienced objectively without any form of interpretation and process based on past knowledge or the impression of similar experiences. At the same time, one’s attention can be flexible, zooming in to focus on details of the experiences while maintaining the broad sense of awareness. This heightened sense of awareness and attentional flexibility are centered on the experiences of that particular moment without the mind drifting to past events or being carried away with thoughts of the future. In short, mindfulness is an adaptive psychological state arising from focusing on the present moment.

Previous literature suggests that dispositional mindfulness might play an important role in disengaging habitual responses and patterns (e.g., Brown and Ryan 2003). For example, mindfulness disposition was found to be negatively correlated with maladaptive habits such as gambling-related problems amongst undergraduates who gamble frequently, after controlling for the frequency of gambling and self-control disposition effects (Lakey et al. 2007). As higher mindfulness disposition is related to higher levels of state mindfulness over time (Brown and Ryan

2003), the clarity of awareness and attention flexibility when one is in a mindful state were found to facilitate more adaptive responses and fewer automated and habitual responses (Bishop et al. 2004; Wenk-Sormaz 2005).

Beyond conceptualizing mindfulness as a disposition, mindfulness appears to be trainable. Research studies on mindfulness-based therapy programs for overcoming maladaptive habits further support the notion that mindfulness is useful in overriding habitual behavioral responses. Randomized clinical trial (RCT) studies have demonstrated the effectiveness of Dialectical Behavioral Therapy (DBT) in enhancing behavioral self-control in the female borderline personality disorder population (e.g., Bohus et al. 2004; Linehan et al. 2002; Verheul et al. 2003), as well as decreasing binge eating episodes and their duration for the eating disorder population (e.g., Safer et al. 2001; Telch et al. 2001). Studies on Acceptance and Commitment Therapy (ACT) also found positive results on reducing drug use (Hayes et al. 2004) and increasing smoking cessation rates (Gifford et al. 2004). A lower rate of cigarette consumption was also recorded following a seven-day follow-up period after a short mindfulness-based intervention (Bowen and Marlett 2009). Sustained mindfulness intervention seems to have a positive effect on behavior change.

Even though mindfulness is considered an inherent human capacity (Brown and Ryan 2003), it nonetheless differs in strength (Brown et al. 2007). Yet with practice mindfulness experiences can become an "effortless trait" (Davis and Hayes 2011, p. 201). Traditional mind-body practices such as meditation and yoga are among the most commonly known methods to develop mindfulness. These practices often require deliberate practice on the individual's part and can be perceived to be time-consuming. Even after going through such training, it is still up to the individual to exert some conscious effort to be mindful in daily life in order to reap the benefits of mindfulness. Thus, the question of how a state of mindfulness can be self-induced most efficiently in normal daily life is an important one and currently remains relatively open.

There are many ways to induce mindfulness. Besides meditation and yoga, there are other variations of mindfulness-inducing methods such as the raisin-eating task (e.g., Kabat-Zinn 1990), walking meditation, and breathing exercises (e.g., Speca et al. 2000) that have been adopted in various contexts. Recently, research on brief mindfulness induction and its immediate effects has been receiving increased attention. Among the studies which examined the behavioral outcome of brief mindfulness induction, we will focus on research involving three different brief mindfulness induction protocols: a card-sorting task, a water-stroking task, and a breathing awareness task. Djikic et al. (2008) primed experimental group participants for an ageism stereotype while inducing mindfulness by asking them to use self-generated categories to sort a pile of cards featuring elderly people before covertly recording their walking speed between two points. They argued that sorting a pile of cards featuring the elderly based on self-generated categories would induce mindfulness aligned to the definition adopted from Langer's work (1978, as cited in Djikic et al. 2008), where novelty seeking and production are components of mindfulness. Their results suggest that the brief mindfulness induction prevented participants in the experimental group from activating their ageism stereotype automatically despite viewing the pictures of the elderly and thus resulted in a faster walking speed when compared to those in the control group who were sorting the same pictures using assigned categories (Djikic et al. 2008). More recent studies by Kee et al. (2012) demonstrated the effect of their brief mindfulness induction based on a water-stroking task in enhancing single-leg balance performances. By instructing participants in the experimental group to pay attention to the sensation of their hand while moving their fully submerged hand in the water, their brief mindfulness induction improved the experimental group's balance performance as compared to the control group, specifically for those with stronger mindful disposition (Kee et al., 2012). The brief mindfulness induction protocol in Kee et al. (2012) was relatively different from Djikic et al. (2008) in that the former adopted Brown and Ryan's (2003) definition of mindfulness, specifically mindfulness as nonjudgmental, bare attention and awareness of the present moment. Kee et al. (2013) conducted another study with a brief mindfulness induction in which participants in the experimental group were asked to pay attention to their breathing and the sensation of their fingers placed under their nostrils; they showed that the capacity for producing random mouse-clicking sequences within a 3 x 3 grid increased significantly for the experimental group as compared to the control group. This breathing awareness task protocol was considered another variation of mindfulness induction based on Brown and Ryan's (2003) definition. Taken together, these studies suggest that the various brief mindfulness induction protocols used influenced the suspension of habitual tendencies, as shown by its effects on the behavioral outcomes of locomotion (Djikic et al. 2008), postural balance (Kee et al. 2012), and the production of random clicking sequences (Kee et al. 2013). This line of findings suggests that brief mindfulness induction has some effects on immediate behavioral change.

While previous studies demonstrate that mindfulness induction protocols such as the card-sorting task, the water-stroking task, and the breathing awareness task, had some effects on behavioral change, none specifically investigated how mindfulness induction had modified well-entrenched behavior directly while having participants intentionally attempting to learn a new skill. We extend this line of research by suggesting that behavioral change could be assessed based on the extent to which well-practiced habits are weakened while learning new ones. The current conceptualization of behavioral change is appropriate as the need for behavioral adjustments occurs in many aspects of daily living, as previously alluded to, and it often calls for the weakening of existing habits while attempting to acquire new ones. For example, in order for Americans to adapt well to driving on the right-hand side of the car, some successes in suspending habitual patterns of the usual left-hand driving are needed, the failure of which might cause the well-learned habits to interfere with the execution of new movements. The literature on this line of evidence (whether habits are weakened) is lacking. Therefore, we conducted a computer-based study to specifically examine the impact of brief mindfulness induction on reducing well-entrenched habits while practicing novel skills. We selected our task based on something that is highly habitual—that of maneuvering a mouse while working on a computer task. Specifically, we asked participants to perform a computer-based target-clicking task, during which mouse direction was normal and reversed (e.g., moving the mouse to the right will cause the cursor on the computer screen to move to the left) for separate sets of trials before and after the manipulation; we examined whether or not the normal mouse movement suffered any deterioration post-manipulation as a result of attempting to adapt to the reversed mouse movement. Based on the understanding that mindfulness is an adaptive psychological quality that facilitates behavioral change, we speculated that participants in the mindfulness group and the control group would differ in the performance of the tasks in a way that suggests the effectiveness of mindfulness induction in changing a behavior. However, given the brief time span over which the experiment was conducted, we were uncertain of how the results might unfold. We relied on the following three measures to study this problem: (a) pre to post-test difference in mean performance time for the target-clicking task in a normal direction; (b) pre to post-test difference in mean performance time for the target-clicking task in a reversed direction; and (c) pre to post-test difference in the number of mistakes made while initiating movement for the target-clicking task performed in a normal direction.

Method

Participants

Thirty-one participants, comprised of 15 male (*M* age = 23.73, *SD* = 2.91) and 16 female (*M* age = 22.44, *SD* = 1.71) university students in Singapore, took part in the study. An email containing information regarding the experiment was sent to a pool of students who had previously expressed interest in volunteering as research participants. Individuals who were interested in the current experiment signed up through a link provided in the email. This study was approved by the university's institutional review board where the study was conducted. All participants had given their informed consent. A token amount of SGD 5 (≈ USD 4) was given to every participant for their involvement in this study.

Measures and Materials

Mindfulness Attention Awareness Scale-State (MAAS-State; Brown and Ryan 2003). The five-item MAAS-State questionnaire was used as a manipulation check instrument to assess state mindfulness post-intervention. An example item was, "I was doing something automatically without being aware of what I was doing." Participants rated these items on a 7-point Likert scale from 0 ("not at all") to 6 ("very much") based on the level of mindfulness experienced in the preceding activity. Higher means derived based on the five items correspond to lower state mindfulness, as the items were phrased in a way that asked about the extent of not being mindful. The items were presented to the participants via the computer program. This scale had been used in Kee et al. (2013) for testing the effects of their mindfulness induction, and they found that participants who underwent their mindfulness induction reported significantly higher MAAS-State scores as compared to participants in the control group.

MouseTracker software (Freeman and Ambady 2010). The MouseTracker software (downloadable ex-gratia from http://www.dartmouth.edu/~freemanlab/mousetracker/index.htm) was used to record participants' real-time computer mouse movements. A rich source of information, such as reaction time and movement coordinates, can be collected using this software. It is easily programmable and the main mouse-clicking task was programmed using this software.

The Target-Clicking Task

In each trial of this task, participants were first presented with a small square icon in the middle of the screen. After clicking this box, a target box would immediately appear in one of the eight positions randomly picked by the program. The eight target boxes were placed about 9.5–13.5 centimeters away from the middle icon on the computer screen, at the 12, 3, 6, and 9 o'clock positions and in the middle between these positions: 12 to 3 o'clock, 3 to 6 o'clock, 6 to 9 o'clock, and 9 to 12 o'clock. The participants were required to move the cursor on the screen to the target and click it as fast as possible. The cursor would then return to the center of the screen automatically before the next trial. The mouse trajectories and temporal information for every trial were recorded. The target-clicking task was used for the test trials and acquisition trials although the mouse directions in both types of trials were different. During the test trials (normal direction), there were a total of eight trials (one in each position). For the acquisition trials (reversed direction), there were a total of 64 trials (eight in each position). Three measures derived for analysis were: (a) test trials' mean performance time (normal direction); (b) acquisition trials' mean performance time (reversed direction); and (c) number of mistakes made when initiating movement during the test trials (normal direction), whereby a mistake is defined by the detection of mouse cursor position beyond 45 degrees to the left or right of the target during the task (taking the start point as the origin). The first two take shorter durations as indicative of better performance, while the third takes lower mistake counts to be indicative of superior performance.

The Mindfulness Induction/Control Condition

In the instruction phase, all participants received pre-recorded audio instructions through a headset to place their index finger underneath their nose. In addition, a picture depicting the required hand position was displayed on screen to the participants. Those in the experimental group were told to pay attention to their breathing, to breathe in and out slowly, and to pay attention to the sensation of their fingers when they were breathing in and out. In addition, they were told that a bell chime would be played periodically during the induction phase to remind them to direct their attention back to their breathing. Participants in the control condition received the basic instructions without the instructions to pay attention to their breathing. The period of induction lasted six minutes for both conditions, where participants sat quietly to perform the task according to their assigned instructions. The bell chime was sounded at the turn of every minute for both conditions.

The protocol for the brief mindfulness induction in the present study was adopted from Kee et al. (2013). This protocol was adopted for a number of reasons: (a) the protocol used to induce mindfulness was aligned to the conceptualization of mindfulness as defined by Brown and Ryan (2003) based on bare awareness of the present moment; (b) such mindfulness strategies could be easily adopted in real life as there was no specific equipment required; and (c) Kee et al. (2013) provided evidence of the effectiveness of this protocol whereby participants in the experimental group in their study reported significantly lower MAAS-State scores (higher state mindfulness) and better voluntary random movement production as compared to participants in the control group.

Procedure

Participants were randomly assigned either the experimental condition or control condition and were seated in a cubicle facing a computer. At the beginning, all participants were asked to sit quietly and rest for six minutes. After the resting period, participants were asked to perform the target-clicking task. They began with the pretest for the test trials, followed by the first set of acquisition trials. Next, they received the instructions for the manipulation of the respective conditions as assigned and underwent the six-minute induction. After this, participants were asked to complete the five-item MAAS-State questionnaire. After completing the questionnaire, they performed the second set of acquisition trials. Finally, they performed the post-test for the test trials. The participants were then debriefed and thanked for their participation. The whole experiment lasted approximately 30 minutes. In summary, the protocol followed this sequence: rest, pretest for the test trials, first acquisition trials, manipulation, second acquisition trials, and post-test for the test trials.

Analyses

To examine manipulation effects, an independent-sample *t*-test was conducted to compare MAAS-State scores between conditions. In the main analyses, the 2 (time: pre-test vs. post-test) by 2 (condition: mindfulness induction vs. control condition) mixed design was adopted to determine whether mindfulness induction has effects on the following dependent variables before and after mindfulness induction: (a) test trials' performance time (normal direction); (b) acquisition trials' performance time (reverse direction); and (c) number of mistakes in terms of initial cursor movements during the test trials (normal direction). The General Linear Model (GLM) was used to examine the interaction effects on the various dependent variables.

Results

In ascertaining manipulation effects, the independent sample *t*-test showed that there was no significant difference in the MAAS-State scores between conditions, $t(29) = 0.723$, $p = .475$, Cohen's $d = 0.27$. There were three extreme cases in the control condition where MAAS-State scores were below 2 and one extreme case in the mindfulness condition where the score was 5. Since those in the control group were expected to report higher MAAS-State scores (denoting lower mindfulness) and the reverse applies for those in the experimental group, we deemed that these four participants were either not following the induction instructions carefully or not responding to the items truthfully. When these cases were deleted, the manipulation check was significant at $t(25) = 2.17$, $p = .04$, Cohen's $d = 0.87$. The mindfulness group scored significantly lower in the MAAS-State ($M = 2.40$, $SD = 0.69$) as compared to the control group ($M = 3.08$, $SD = 0.92$). These results indicate that the mindfulness induction can be considered to be effective. Nevertheless, we retained the entire sample for our main analyses as the results did not differ even when these extreme cases were dropped.

Next, we provide some statistics to describe the entire sample. In the test trials (normal direction), mean performance time for the pre-test was 979.69 ms (*SD* = 114.15 ms) for the entire sample, and that of the post-test was 1312.60 ms (*SD* = 345.82 ms). The change between two time points was significantly different, $t(30) = -5.61$, $p = .000$. The first acquisition trial performance (reverse direction) in terms of mean trials completion time was 1716.75 ms (*SD* = 337.60 ms) and that of the second acquisition trial was 1523.70 ms (*SD* = 142.61 ms). The difference was also significant, $t(30) = 4.62$, $p = .000$. The mean number of mistakes detected for the pre-test test trials (normal direction) was 4.29 (*SD* = 1.66), and for the post-test test trials was 4.39 (*SD* = 2.19). The difference was non-significant. Further details on these measures for the different conditions and phases are shown in Table 1.

In the main analyses, we found significant interaction effects for the analysis on number of mistakes as the dependent variable, but on not for the other two dependent variables. The test trials mean performance time was an indication of how fast each trial (normal direction) was completed. Results showed that the interaction analysis between time and condition in the test trials mean performance time was not significant [$F(1, 29) = 2.48$, $p = .13$, $\eta_p^2 = .079$]. The acquisition trials mean performance time was an indication of performance for trials done in the reversed direction. Results showed that the interaction analysis between time and condition in the acquisition trials mean performance time was also not significant [$F(1, 29) = 1.81$, $p = .19$, $\eta_p^2 = .058$]. Lastly, the number of mistakes in the initial movements during the test trials was used as a proxy for assessing how participants were moving contrary to their intentions. Results showed that there was a significant interaction between time and condition in terms of the number of trials with mistakes [$F(1, 29) = 9.77$, $p = .004$, $\eta_p^2 = .252$]. Figure 1 depicts the interaction graphically. Simple effect analysis showed that there was no significant difference in the number of mistakes made between the experimental and control groups in the pretest [$t(29) = 1.64$, $p = .111$, Cohen's d = 0.59]. However, participants in the experimental group made significantly more mistakes than the control group in the post-test [$t(29) = -2.76$, p =.099]. Participants in the experimental group made significantly more mistakes in the post-test compared to the pretest [$t(14) = -3.96$, $p = .001$, Cohen's $d = 1.02$], but no significant difference was observed for that of the control group [$t(15) = 1.85$, $p = .085$, Cohen's $d = 0.59$].

Discussion

In this present study, we investigated the effect of brief mindfulness induction on the weakening of habits based on a computer-based experiment. We initially speculated that participants in the mindfulness group and the control group should differ in the performance of the tasks, in a way that suggests effectiveness of the mindfulness induction in changing behavior. We did not detect significant differences between the experimental and control groups in both test and acquisition trials' mean performance times across the two time points. However, we found that participants who received the mindfulness manipulation made significantly more mistakes in the post-test compared to the pretest, while no significant difference was observed for that of the control group.

The present findings seem to contradict the notion that mindfulness is an adaptive psychological quality that improves physical performance, such as those reported by Kee et al. (2012). Here, we report that mindfulness had no effect on improving performance time in the acquisition trials (reverse direction) and furthermore, those in the mindfulness group made more mistakes in the test trials (normal direction) after the induction phase. Nonetheless, we could also interpret the adaptability of a brief mindfulness effect in terms of the extent to which originally well-established habits became weakened, at least temporarily. A possibility is that the brief mindfulness induction had resulted in increased engagement during the second acquisition trials. Although no measure of engagement was measured, previous works linked mindfulness to task engagement (e.g., Daiz 2013; Langer 1989), and we suspected that engagement during the second acquisition trials could have increased due to the brief mindfulness induction. The increased engagement in the second acquisition task, while not translating to an increase in performance, might have caused the mistakes in the post-test for the test trials to increase. We further propose that task engagement toward a to-be-learned task might be a mediator in the causal link between mindfulness and the weakening of previous habit. This conjecture certainly warrants further investigation.

In applying the findings of this study to real-life settings, when one is trying to replace an unwanted habit with a desirable habit, perhaps a brief mindfulness induction or practice may lead to the weakening of the unwanted habit, especially when there is strong engagement in the practice of the new habit due to mindfulness. This study may have consequences for the understanding of how motor skills are developed as a result of mindfulness during the learning process, something which has received some recent interest (Kee and Liu 2011). This finding also corroborates with earlier studies which found the facilitative effects of brief mindfulness induction in other motor control tasks, such as those reported by Kee et al. (2013) and Kee et al. (2012). We suggest that a brief bout of mindful attention toward a target of focus, such as one's breath, could elicit beneficial psychological effects that support the disengagement of habitual actions.

From another angle, however, the effects of brief mindfulness induction may not be entirely positive since original desirable habitual patterns could also deteriorate as a result of mindfulness. This finding, in particular, may serve as a caution for unexpected consequences of mindfulness, specifically that of losing one's well-drilled skills temporarily and unwantedly. Consider the case of adapting to a new traffic orientation in which the American driver, utilizing mindfulness practices on the go, would drive mindfully when in the UK given the new road conditions. After driving in the opposite orientation for an extended period of time, the added mindfulness and engagement in his or her driving in the UK might cause them to have some trouble adjusting back to American traffic conventions when he or she returns. This could also be true in other situations; for example, if one is intently mindful while operating new machines in an industrial setting, a temporary loss of existing habits for operating familiar machines might be triggered, potentially resulting in accidents. Of course, such speculations remain to be ascertained but possible unexpected effects of mindfulness should be noted.

There are some limitations in the present study that must be noted. First, the sample size is relatively small. Although we found a reasonably strong effect and significant results for the number of mistakes made, the findings should be viewed with caution. Secondly, the task that we used only concerns hand movements. Although the simplicity of the task affords us a window to detect minute changes in directions of mouse movement as a proxy for mistakes made, the generalization of the findings to habitual tendencies of behavior on the level of all human may be somewhat limited as a result of our task choice. To improve the ecological validity of the findings, future studies could examine the effects of mindfulness on real-life tasks where performance measurement is also possible, such as text typing, to see if learning to type on an unfamiliar keyboard weakens existing typing habits after mindfulness induction. Finally, a small number of participants did not seem to adhere to the mindfulness manipulation or react to the induction as we had intended. There could be some issues with the interpretation of instructions for some individuals.

In conclusion, the present study found that brief mindfulness induction could subsequently result in the weakening of initial habits. The findings are situated within the discussion on mindfulness as a strategy to facilitate habitual change and will hopefully spur further research on the effects of mindfulness.

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			Pre		Post			
		n	*M* (ms)	*SD* (ms)	*M* (ms)	*SD* (ms)	*t*	*p value*
Experimental	Test Trial	15	950.88a	75.23	1377.98	337.83	-4.52	.000
	Acquisition Trial	15	1636.49	215.93	1500.61	141.98	4.70	.000
	Mistakes Count	15	3.80	1.57	5.40	1.84	-2.70	.017
Control	Test Trial	16	1006.69	138.46	1251.30	352.68	-3.55	.003
	Acquisition Trial	16	1791.98	414.67	1545.35	144.32	3.28	.005
	Mistakes Count	16	4.75	1.65	3.44	2.10	1.85	.085

T*able 1. Descriptive and inferential statistics for test trial performance times, acquisition trial performance times, and number of mistakes, between experimental group and control group, before and after manipulation.*

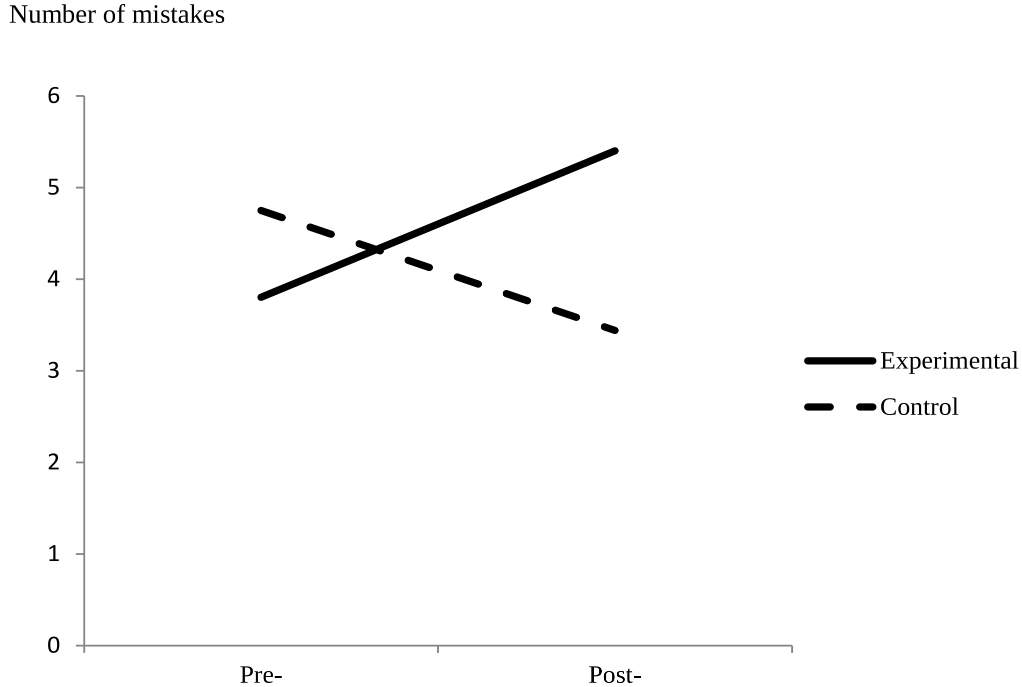

Figure 1. Significant interaction effects for manipulation by time for number of mistakes