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Absent minds and absent agents: Attention-lapse induced alienation of agency

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Abstract

We report a novel task designed to elicit transient attention-lapse induced alienation (ALIA) of agency experiences in normal participants. When attention-related action slips occur during the task, participants reported substantially decreased self control as well as a high degree of perceived agency attributed to the errant hand. In addition, participants reported being surprised by, and annoyed with, the actions of the errant hand. We argue that ALIA experiences occur because of constraints imposed by the close and precise temporal relations between intention formation and a contrary action employed in this paradigm. We note similarities between ALIA experiences and anarchic hand sign (AHS) and argue that, despite important differences, both ALIA experiences and AHS phenomenology reflect failures of executive control to intervene and cancel contrary affordance-driven habitual motor plans.

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Introduction

Sometimes you become aware of something that you wanted to do only after you have done it. Your body decided for you, it picked a desire and carried it out.

– Wu Ming – Momodou

To be an agent means, most fundamentally, to be in control of one's own bodily actions. Phenomenologically, this entails the feeling that one's actions "obey" one's concurrent action intentions. Yet surprisingly few of our everyday actions are explicitly willed. In everyday life, automatic behaviors are likely much more common than explicitly intended actions (e.g., Bargh & Chartrand, 1999). Most often, these actions are functional and accomplish what we take to have been our implicit goals. Occasionally, however, our automatic actions do go awry. Everyday cases of dysfunctional automaticity include absent-minded actions when, for example:

I remove the wrapping from a candy, walk over to a garbage bin and, to my almost immediate chagrin, discard the candy with one hand and retain the wrapper in the other.

I reach into a bathroom cabinet for a bottle of aspirin, and am surprised to find myself a few moments later brushing my teeth.

These examples highlight everyday action slips (Norman, 1981; Reason, 1979) as failures of self-awareness during instrumental action (Baars, 1992, 1993; Eilan & Roessler, 2003; Heckhausen & Beckman, 1990; Zhu, 2004). Note that the examples describe not simple reflex movements but skilled, goal-directed actions, though inconsistent with concurrent intentions. People often react to such absent-minded actions, their common occurrence notwithstanding, with surprise, embarrassment, and annoyance. Such unintended actions are generally brought to our attention via unexpected, and usually unwanted, action outcomes.

In the present paper we explore whether action slips that occur during bouts of mind wandering can at times lead to more than mere feelings of automaticity but rather elicit the feeling that the body part involved in the action slip willfully violated one's intentions as if it had a mind of its own (i.e., an alienation of agency). The behavioral pattern during action slips such as those described above is reminiscent of the uncontrolled behaviors of individuals with an Anarchic Hand Sign (AHS; cf. Della Sala, 2005; Eilan & Roessler, 2003; Marcel, 2003), a condition characterized by episodes such as the following:

A man is sitting watching television. He reaches out with one hand and selects a program. His other hand, to his chagrin, selects another channel (Parkin & Barry, 1996).

A diner finishes a meal but observes with horror that one hand continues to put food from another person's plate to her mouth (Della Sala, Marchetti, & Spinnler, 1994).

Patients react to their misbehaving hands with surprise, embarrassment, and annoyance (Della Sala et al., 1994). In addition they often personify the hand and address it as a different and difficult person having a "will of its own" (Della Sala et al., 1994). The foregoing examples illustrate core features of AHS and highlight the actions of the anarchic hand, like action slips, not as simple reflexes but as well-executed, goal-directed actions (Marchetti & Della Sala, 1998). Nonetheless, these actions are experientially independent of the explicit concurrent goals and intentions of their owners (Biran, Giovannetti, Buxbaum, & Chatterjee, 2006; Della Sala, Marchetti, & Spinnler, 1991; Della Sala et al., 1994; Feinberg, Schindler, Flanagan, & Haber, 1992; Goldberg, 1985; Goldberg & Bloom, 1990; Kritikos, Breen, & Mattingly, 2005; Marchetti & Della Sala, 1998; Parkin & Barry, 1996). Though patients deny having volitional control over such actions, they do not deny ownership of, or fail to recognize, the offending hand as their own, in contrast to neurological conditions with which AHS is often confused (Della Sala et al., 1991, 1994). Nor do they deny that the unwanted actions occurred or even that the actions are *intentional*. Rather, the intentions do not seem to be *their* concurrent intentions and hence agency is transferred from self to hand. Such patients have experienced not merely a loss, but an active alienation, of agency for the anarchic actions. Finally, such patients are not delusional. As one patient put it: "Of course I know that I am doing it. It just doesn't feel like me" (Marcel, 2003, p. 79).

Though AHS phenomena initially seem uncanny and remote from normal human experience, similarities to absent-minded actions of normal individuals are, upon reflection, quite striking and raise the possibility that absent-minded action could, under specific circumstances lead to the experience of alienation even in otherwise normal individuals. Indeed, parallels between AHS and normal cognition have been drawn before (e.g., Humphreys & Riddoch, 2003; Riddoch, Humphreys, &Edwards, 2000), as well as specific analogies between absent-minded actions and AHS (Della Sala, 2005; Eilan & Roessler, 2003). Indeed, there is evidence of increased absent-mindedness associated with AHS, in the form of frequent tapping, scratching, and fidgeting with objects (Biran et al., 2006). It is also the case that AHS patients do not always become aware of the anarchic movements of their affected hands (Biran et al., 2006). Moreover, the surprise evinced the AHS patient when attending to his errant hand's actions is perhaps not different in kind from the experience of seeing one's candy disappear into a rubbish bin, or of being startled by the sound of a ring or pen hitting the floor and realizing that we must have been absent-mindedly "fiddling" with the object. Of course, absent-minded action slips seldom lead to outright anarchic experiences. They are very brief and innocuous compared to AHS experiences though they would appear to instantiate at least some of the conditions for such experiences as they do, for example, entail complex, functional activities. Critically, however, what absent-minded slips seldom entail are activities that are explicitly countermanded by our current intentions and this lack of conflict with our intentions likely prevents even blatant absent-minded action slips from typically being perceived as explicit violations of agency.

An observation and hypothesis

. . . the action seemed to start in the finger itself, not in some part of her mind.

– Ian McEwan – Atonement

Nonetheless the possibility that that alienation could occur under special circumstances during specific absent-minded actions occurred to us during self observation while piloting a version of the Sustained Attention to Response Task (SART; Robertson, Manly, Andrade, Baddeley, & Yiend, 1997) commonly used to study behavioral consequences of mind wandering or absent-mindedness (Cheyne, Carriere, & Smilek, 2006; Cheyne, Solman, Carriere, & Smilek, 2009; Smallwood, Beach, Schooler, & Handy, 2008; Smallwood, McSpadden, & Schooler, 2007). During SART performance, participants press a key whenever a number appears on a computer screen unless a particular and infrequent (target) number appears, in which case they must withhold a response. Participants have no difficulty seeing and identifying the target number, but frequently fail to withhold a response on NOGO trials. Failures to withhold a response on NOGO trials during the SART have been shown to coincide with subjective reports of mind wandering (Smallwood et al., 2007, 2008) and the propensity for making these SART errors is correlated with self reported measures of absent-mindedness (Cheyne et al., 2006). Importantly, we have noticed as well that both we and our participants often express surprise at the all too frequent failures to withhold the prohibited response, sometimes feeling that they were aware of the errors even while making them. Thus, in a mild and non-pathological sense, it seems that during bouts of mind wandering our hands can briefly seem anarchic.

In light of these considerations, we sought to evaluate whether action slips that occur during bouts of mind wandering may at times lead to the feeling that the body part involved in the action slip has a mind of its own (i.e., an alienation of agency). To address this issue we sought to develop a procedure for producing mild and transient attention-lapse induced alienation (ALIA) of agency experiences in normal participants. To this end, we designed a modified SART-like task, the Response Switching Task (RST). In this task two actions are placed in conflict on infrequent switch trials that require both inhibition of the more frequently responding (*default*) hand and an active response with a different (*switch*) hand. The advantage of this task over the SART task for present purposes is that it creates a situation where the correct action and the action slip are manifested as opposing actions of the two hands (analogous to the "good" and "bad" hands of AHS), with the latter being in direct conflict to one's immediate updated intention. We expected that this task, more than the unimanual SART, would mimic the situation typically experienced by individuals with AHS. Accordingly, we predicted that the errors caused by mind wandering during the RST would be accompanied by a readily detectable alienation of the offending hand. Our specific prediction is that failures to inhibit the default hand on switch trials will lead to a transfer of the sense of control from the self to the default hand. We also examined subjective reactions (surprise and annoyance) to performance on the task.

Experiment 1

Method

Participants

Participants were 16 university undergraduates (mean age = 18.90; 14 right-handed; eight females) from the University of Waterloo. All participants had normal or corrected to normal vision.

Stimuli and apparatus

An LG flatron F700B 1700 monitor at a resolution of 1024 x 768 pixels was controlled by an 800 MHz Pentium III processor running E-prime software. Participants responded using a standard PS/2 keyboard. In keeping with our (Cheyne et al., 2006) previous use of the SART (Robertson et al., 1997) the digits 1 through 9 were displayed in white Symbol font against a black background at a randomly selected size of 48, 72, 94, 100, or 120 points. Digit size varied from 16 to 67 pixels horizontally (5.1–21.3 mm), subtending from 0.5 to 1.9 degrees of visual angle horizontally at a viewing distance of 55 cm, and from 43 to 110 pixels vertically (13.7–34.9 mm), subtending from 1.2 to 3.2 degrees of visual angle vertically. Following each digit, a mask consisting of a circled cross was displayed in white 120 point Symbol font, with a radius of 111 pixels (35.3 mm) subtending 3.2 degrees of visual angle.

Design and procedure

Participants responded with a key press to each digit. In one block of trials, participants were instructed to press the 'M' key with their right (default) hand when the digit was anything other than a 3 (default trials). When the digit was a 3 (switch trials) participants were instructed to withhold their response with the default hand and instead press the 'Z' key with their left (switch) hand. Participants were instructed that even if they responded incorrectly (e.g., pressing the default key on a switch trial) it was always necessary to make the switch response by pressing the appropriate key. In an additional block of trials the default and switch hands were reversed, such that each participant completed one block of trials with the right hand as the default hand and one block of trials with the left hand as the default hand. The order in which these blocks were completed was counterbalanced across participants.

For each trial a digit from 1 to 9 was presented individually in the center of screen for 250 ms followed by a mask for 900 ms. The order of presentation of digits within the 1–9 sequence was randomly distributed, with each digit being displayed once before the sequence was reshuffled. Participants initiated each block of trials by pressing a key. Prior to each block of experimental trials participants completed a short practice set of 27 trials, during which judgments were collected following each of three switch trials, to allow participants to become familiar with the responses and judgments required for that block. The two blocks of experimental trials each included 756 trials.

Following selected switch trials, participants were asked to make judgments about their response for that trial. Participants were initially asked to make these judgments after incorrect responses on switch trials. These judgments were collected following 18 incorrect switch trial responses, and were also collected following a matched number of subsequent correct switch trial responses. If multiple incorrect responses occurred prior to a correct response, then an equal number of correct switch trial response judgments were collected as they occurred. This judgment pairing ensured a close temporal relation between correct and incorrect response judgments. After 18 incorrect switch responses and 18 correct switch responses the trials continued without requesting any further judgments. Following each set of judgments, the same center cross mask as used within each trial was displayed for 3000 ms to allow participants to prepare for the start of the next trial.

Participants were required to make three distinct types of judgment following correct and incorrect switch trials throughout the task, together assessing (in order of presentation) control, annoyance, and surprise (Fig. 1). Subjective transfer of control from self to a specified hand (control judgment) was assessed by ratings of relative sense of response control for oneself versus one's hand on a 1 (self control)–7 (hand control) Likert scale. Annoyance with either oneself or the response of a specified hand (annoyance judgment) was assessed using a 1 (low)–7 (high) Likert scale. Finally, surprise at the response of a specified hand (surprise judgment) was also assessed using a 1 (low)–7 (high) Likert scale. The target of reference for the control and surprise judgments alternated equally between the default and switch hands across trials. For annoyance, each of the three judgment targets (default hand, switch hand, and self) was referenced on one third of the trials.

This study received ethics clearance from the Office of Research Ethics at the University of Waterloo.

Fig. 1. Questions used for participants to make judgments about their responses to the preceding trial. (A) Rating of Control, judgments alternated between default and switch hands. (B) Rating of Annoyance, judgments alternated between self, default hand, and switch hand. (C) Rating of Surprise, judgments alternated between default and switch hand. The judgment asked for alternated sequentially within each group (A, B, C) from trial to trial.

Results and discussion

We begin by describing the behavioral results of the RST to demonstrate that performance on the RST is very similar to performance on the SART. We then describe the subjective judgments of control, surprise and annoyance.

Attention lapses during the RST

Overall performance on the RST was comparable to that found previously in our use of the SART (Cheyne et al., 2006). Participants provided correct responses to the stimulus within 360 ms on the more frequent default trials and 473 ms on the relatively infrequent switch trials (Table 1). As well, participants failed to provide the correct response for 1% of default trials and 39% of switch trials. The similarity in performance is consistent with the procedural similarities between the RST and SART, suggesting performance continues to be influenced by one's ability to remain attentive.

Table 1
Means (standard deviations) for reaction times and number of response errors ($N = 16$) for Experiment 1.

Default hand	Reaction times		Response errors	
	Default hand	Switch hand	Default trials	Switch trials
Non-dominant	353.78 (98.14)	476.05 (80.67)	10.19 (9.79)	36.69 (19.12)
Dominant	366.41 (106.27)	470.28 (82.06)	5.56 (3.69)	29.13 (16.57)
Overall	360.10 (99.04)	473.17 (78.20)	15.75 (11.26)	65.81 (32.80)

In addition to the commission of errors, RT speeding during the SART has been interpreted as signaling the impairment of executive functioning and automatization of behavior which is characteristic of mind wandering and is strongly associated with errors (Cheyne et al., 2006; Manly, Robertson, Galloway, & Hawkins, 1999; Robertson et al., 1997; Smallwood et al., 2007). Hence, we examined RTs for: both hands on incorrect switch trials; the default hand on default trials and the three trials prior to switch trials; and the switch hand on correct switch trials. A one-way ANOVA yielded a robust significant effect, $F(1,15) = 100.73$, $p < .001$, $\eta^2 = .87$. Planned *t*-tests indicated that RTs for incorrect switch trials were faster than RTs preceding switch errors, which were, in turn, significantly faster than overall default RTs, all *p*s < .01 (Fig. 2, shaded bars). RTs for the switch hand were slightly more than 100 ms slower than RTs for default trials, $p < .001$, consistent with findings of this magnitude of delay for selective inhibition (Coxon, Stinear, & Byblow, 2007). RTs for the switch hand on incorrect switch trials were yet another 100 ms slower than for correct switch trials, $p < .001$. RTs for switch hands were also consistently much slower than RTs for default hands under any other condition, all *p*s < .001 (Fig. 2, clear bars). The slower RTs for the switch hands likely reflect a two-stage selective inhibition process (Isoda & Hikiosaka, 2007); the first stage consisting of initial nonselective inhibition via a the cortico-motor pathway from pre-frontal cortex via basal ganglia generally suppressing M1 followed by a second (partially overlapping) stage selectively releasing the switch hand from inhibition (Aron, Robbins, & Poldrack, 2004; Coxon et al., 2007).

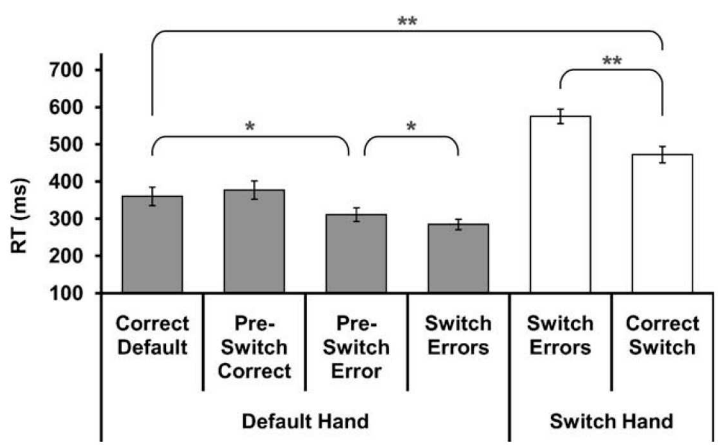

Fig. 2. Experiment 1: means and *SE*s for reaction times (RTs) for default hand for default trials, three trials prior to switch trials, and during incorrect switch trials, and for the switch hand on correct and incorrect switch trials. $^{*}p < .01$; $^{**}p < .001$.

Ratings of control

Having described participants' performance on the RST, we next examine the effects of switch errors on perceived locus of control. The mean control ratings for each condition are shown in Fig. 3. A 2 (dominant versus non-dominant hand) by 2 (order: left, right default hand in block 1) by 2 (performance: incorrect, correct switch trials) by 2 (target: default hand versus switch hand rating) ANOVA yielded significant main effects for incorrect versus correct switch trials, $F(1,14) = 20.94$, $p < .001$, $\eta^2 = .60$, default versus switch hand, $F(1,14) = 33.67$, $p < .001$, $\eta^2 = .71$, and a significant interaction between incorrect versus correct trials and default versus switch hand, $F(1,14) = 31.98$, $p < .001$, $\eta^2 = .70$. Planned comparisons indicated that the transfer of the sense of control to the hand was significantly greater for the default hand on switch errors than on correct switch trials and greater than for the switch hand on either correct or incorrect switch trials, all *p*s < .001. In addition, only control ratings for the default hand on switch error trials were significantly above the mid-point of the scale, $p < .001$, which, although unlabeled for participants, iconically represents the point where one feels neither a high degree of self control nor a high degree of hand control. Thus, participants reported a relatively strong alienation of agency for only the default hand, and only when it had just committed an error.

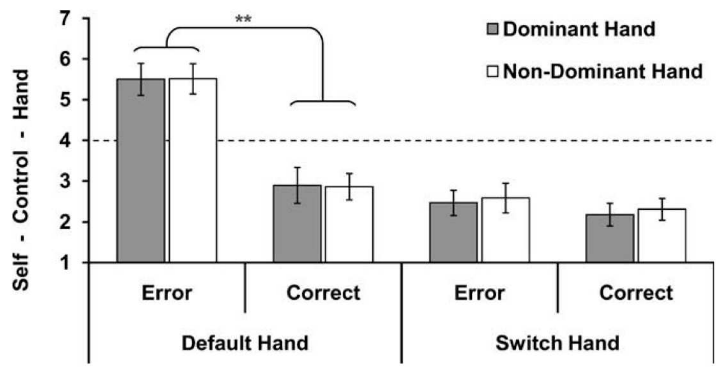

Fig. 3. Experiment 1: means and *SEs* for ratings of control following switch trial errors for default and switch hands (higher scores indicate greater transfer of control to the hand). $^{*}p < .001$.

Ratings of surprise

A parallel ANOVA for surprise yielded a significant main effect for incorrect versus correct switch trials, $F(1,14) = 26.11$, $p < .001$, $\eta^2 = .65$. Surprise was greater following incorrect than following correct switch trials (See Fig. 4A). No other effects were significant.

Ratings of annoyance

The mean annoyance ratings for each condition are shown in Fig. 4B. The analysis of the annoyance ratings was similar to the previous analyses except that there were three levels of the target factor (default hand versus switch hand versus self rating) and block was included to test for increased annoyance over time. There was a significant main effect for incorrect versus correct switch trials, $F(1,14) = 42.02$, $p < .001$, $\eta^2 = .75$ and a block effect, $F(1,14) = 4.76$, $p < .016$, $\eta^2 = .35$. Annoyance ratings increased from block 1 (Mean = 2.80, SD = 1.69) to block 2 (Mean = 3.18, SD = 1.68). Planned pair-wise comparisons of means for each annoyance rating (default hand, switch hand, self) revealed that annoyance with only the default hand increased significantly from block 1 (Mean = 3.83, SD = 1.66) to block 2 (Mean = 4.64, SD = 1.63), $t(15) = 2.99$, $p < .025$.

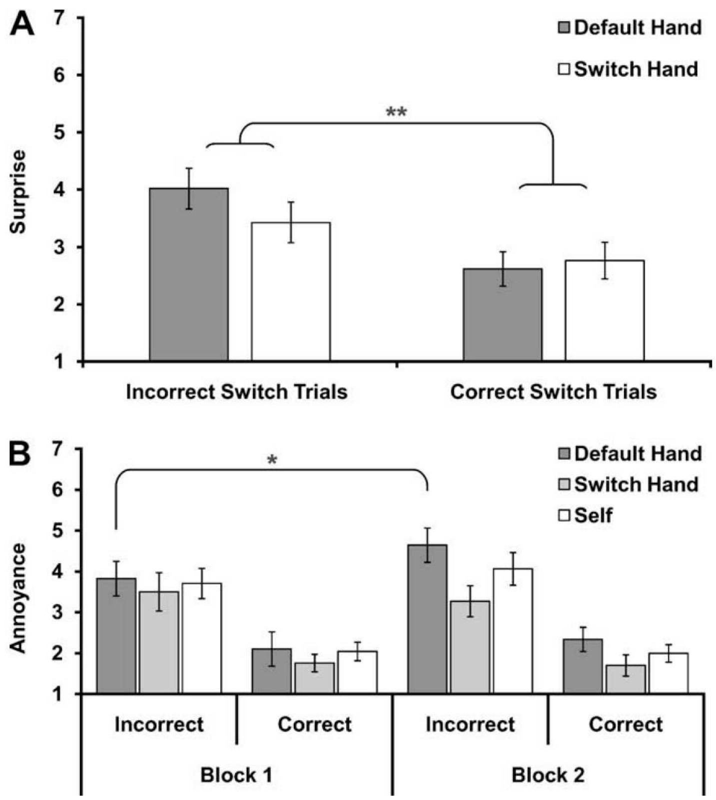

Fig. 4. (A) Experiment 1: means and *SE*s for ratings of surprise following switch trial errors for default and switch hands. (B) Experiment 1: means and *SE*s for ratings of annoyance following switch trial errors for default hand and switch hand and self (higher scores indicate greater annoyance). $^{*}p < .05$; $^{**}p < .001$.

The foregoing result, and the absence of a similar block effect in a follow-up ANOVA for control ratings, suggested that the increasing annoyance with the default hand was a consequence, rather than a cause, of an earlier transfer of control (in block1). To test this hypothesis, two sets of multiple regression analyses were conducted. One predicted annoyance in block 2 using annoyance in block 1 and control transfer in block 1. The other predicted control transfer in block 2 using control transfer in block 1 and annoyance in block 1. In each case, the question was whether the cross-lagged association between control and annoyance added to the predictive power of the autocorrelation. Control transfer in block 1 added significantly and robustly to the prediction of annoyance in block 2, yielding a substantial R^2 change and overall improvement of model fit (Table 2A). Indeed, the simple cross-lagged correlation was numerically equal to the autocorrelation for annoyance with the default hand ($r = .68$). In contrast, the small, non-significant R^2 change revealed no contribution of annoyance with the default hand in block 1 to control transfer in block 2 (Table 2B).

Table 2A
Multiple regression analysis predicting block 2 annoyance rating with default hand from block 1 annoyance and control.

	β	t	p
Model 1			
Annoyance: block 1	0.68	3.50	.004
	$R^2 = .47$, $F(1,14) = 12.22$, $p < .004$		
Model 2			
Annoyance: block 1	0.49	2.85	.014
Control: block 1	0.49	2.86	.013
	$R^2_{change} = .21$, $F(1,14) = 8.20$, $p < .013$ $R^2 = .67$, $F(1,13) = 13.35$, $p < .001$		

Table 2B
Multiple regression analysis predicting block 2 control rating of default hand with block 2 control and annoyance.

	β	t	p
Model 1			
Control: block 1	0.84	5.69	.001
	$R^2 = .70$, $F(1,14) = 32.33$, $p < .001$		
Model 2			
Control: block 1	0.79	4.87	.001
Annoyance: block 1	0.12	0.75	.468
	$R^2_{change} = .01$, $F(1,14) = 0.56$, $p < .468$ $R^2 = .71$, $F(1,13) = 15.93$, $p < .001$		

Summary

Our findings with the RST successfully replicated previous findings with similar tasks, observing speeding of RST RTs immediately prior to, and during, switch errors, consistent with mind wandering and a loss of executive control. We found a substantial transfer of control from self to hand, and this occurred following trials that were associated with response speeding – an index of loss of executive control during mind wandering. Critically, the effects of switch errors on perceived control were strong and specific to the default hand making the task-inappropriate response on that trial. Subjective ratings of surprise and annoyance also increased when errors were committed, but the degree of hand specificity was less for surprise and annoyance than for control. The loss and transfer of control was therefore likely not a consequence of surprise or annoyance and hence not simply an attempt to disown the error or comply with implicit experimental demands. Although there was some evidence for increasing specificity of annoyance in block 2, the regression analysis provided evidence that the transfer of control preceded and predicted the shift of annoyance to the erring default hand. Overall, therefore, these results suggest that during the commission of attention-related errors participants can experience brief moments of alienation of their hand.

Experiment 2

In Experiment 1, a forced-choice format contrasting self and hand agency did not allow for an independent assessment of the relative loss of self control and the assignment of agency to the hand. A high score on the scale might reflect a loss of self control but be experienced simply as a feeling of automaticity, rather than active agency of the hand. Hence, in Experiment 2, self and hand agency were assessed independently on separate scales, allowing participants to independently indicate their experiences of self and hand agency. With these measures, alienation of the hand would be indicated by low ratings on the self control scale but high ratings on the hand control scale. Participants were told to indicate automatic responding without alienation with low ratings on both the self and hand control scales. In this way, we were able to distinguish between the experience of automatic responding and the experience of hand alienation.

Another difference between Experiments 1 and 2 involved the trials on which we elicited subjective judgments. In addition to collecting subjective ratings on correct and incorrect switch trials, as we did in Experiment 1, subjective ratings were also obtained for a randomly selected comparable number of default trials. We predicted that participants would rate self control to be low and hand control to be high on switch error trials only, which would mean they experienced a specific alienation of the offending hand.

Finally, in Experiment 2 we also attempted to make the contrast between intention and action more explicit. A distinction has been made between explicit prior intentions, such as forming an intention to take a coffee break at 10:00 pm and more implicit intentions-in-action, such as reaching for the cup of coffee (Searle, 1983). This latter form of intention is aptly described as “thin and evasive” (Haggard, 2005, p. 291). Although the temporal relation between explicit prior intentions and action often represents a much longer time scale than intentions-in-action, they also can be made “on-the-fly” and may serve to initiate and accompany intentions-in-action. In pilot work we were particularly struck with the ALIA effect when explicitly reading the digits aloud. We speculated that reading aloud might make the inconsistency between intention and action on the failed switch trial more explicit and contribute to the ALIA effect.

Method

Participants

Participants were 16 university undergraduates (mean age = 22.3; all right-handed; 11 females) from the University of Waterloo. All participants had normal or corrected to normal vision.

Stimuli and apparatus

The stimuli and apparatus were the same as those used in Experiment 1. In addition, voice response reaction times were collected via a positionable tripod-mounted microphone connected to a Psychology Software Tools serial response box.

Design and procedure

As in Experiment 1 participants responded with a key press to each digit. All participants were right-handed and were instructed to press the ‘M’ key with their right hand (default hand) when the displayed digit was anything other than a 3 (default trials). When the displayed digit was a 3 (switch trials) participants were instructed to withhold their response with the default hand and instead press the ‘Z’ key with their left hand (switch hand). Participants were instructed that, even if they incorrectly pressed the wrong key (e.g., the default key on a switch trial), it was still necessary to press the correct key with the switch hand.

For each trial a digit from 1 to 9 was presented individually in the center of the screen for 250 ms followed by a mask for 900 ms. The order of presentation of digits within the 1–9 sequence was randomly distributed, with each digit being displayed once before the sequence was reshuffled. Unlike Experiment 1, participants completed only one block of experimental trials in Experiment 2. Prior to the experimental trials participants completed a short practice set of 27 trials, during which judgments were collected following 2 out of 3 switch trials as well as 2 out of 24 default trials, to allow participants to become familiar with the responses and judgments required for the task. Instructions on how to interpret the judgment questions were provided as each question was encountered during the practice trials. Participants completed a total of 360 experimental trials.

Following selected default and switch trials participants were asked to make judgments about their response for that trial. Judgments were collected on up to 6 switch trials following incorrect responses and were also collected for a matched number of subsequent correct switch trials. If multiple incorrect responses occurred prior to the next correct response, then an equal number of correct response judgments were collected as soon as they occurred. After six incorrect switch responses and six correct switch responses the trials continued without further judgments being collected for switch trials. In addition to the judgments following switch trials, judgments were collected following six randomly selected default trials, with two of these judgments always occurring within the first 36 trials of the experimental set. Following each set of judgments, the same center cross mask as used within each trial was displayed for 3000 ms to allow participants to prepare for the start of the next trial.

Participants made two types of judgment about their actions throughout the task, always with reference to their response for the immediately preceding trial. Each type of judgment (Fig. 5) was a variation on the control judgment employed in Experiment 1. One judgment assessed participants’ subjective experience of alienation from the action of a specified hand by ratings of the extent to which that hand took control of its response, on a 1 (not at all)–7 (completely) Likert scale. A second judgment assessed their subjective experience of self control, also on a 1 (not at all)–7 (completely) Likert scale. *Participants were instructed to assign lower values for both scales if their action felt purely automatic.* Alienation judgments were collected for the default hand following default trials, and for either the default or switch hand following switch trials. Alienation judgments were collected following six randomly selected default trials, up to six switch errors (three per hand), and up to six correct switch trials (three per hand, based on the number of switch errors committed), for a maximum of 18 times in total. Self control judgments were collected in conjunction with each alienation judgment, and thus were collected a maximum of 18 times as well. The order of judgment presentation was counterbalanced throughout the task.

This study received ethics clearance from the Office of Research Ethics at the University of Waterloo.

Fig. 5. Questions used for participants to make judgments about their responses to the preceding trial in Experiment 2. (A) Rating of alienation, judgments alternated between the default and switch hands. (B) Rating of self control.

Results and discussion

Attention lapses during the RST

The mean number of errors was 14.06 (SD = 7.42) of 40 switch trials for a 35% switch trial error rate, and 7.13 (SD = 8.37) of 320 default trials for a 2.23% default trial error rate. We again examined RTs for incorrect switch trials, the default hand on default trials and the three trials prior to switch trials, and the switch hand on correct switch trials. A one-way ANOVA yielded a highly significant effect, $F(1,15) = 93.39$, $p < .001$, $\eta^2 = .87$. Planned *t*-tests indicated that default hand RTs for incorrect switch trials were faster than RTs before switch errors, which were, in turn, significantly faster than overall default RTs, all *p*s < .01 (Fig. 6). RTs for the switch hand were more than 100 ms slower than RTs on default trials, $p < .001$ and RTs for the switch hand on incorrect switch trials were about 200 ms slower than for correct switch trials, $p < .001$. RTs for the switch hand were consistently much slower than RTs for the default hand under any other condition, all *p*s < .001. These results and the pattern of RTs were virtually identical to those for Experiment 1 (See Fig. 2).

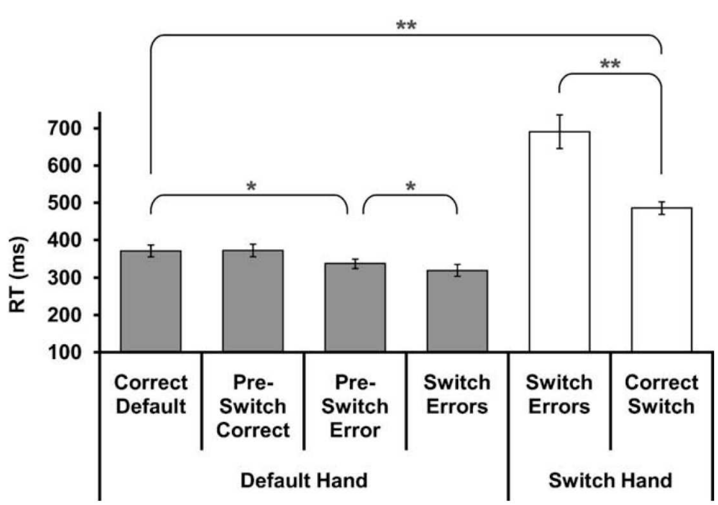

Fig. 6. Experiment 2: means and *SE*s for reaction times (RTs) for default hand for default trials, three trials prior to switch trials, and during incorrect switch trials, and for the switch hand on correct and incorrect switch trials. $^{*}p < .01$; $^{**}p < .001$.

Alienation of control ratings

The mean scores on the alienation of hand control rating scale for each condition are shown in Fig. 7A. A 2 (default versus switch hand) by 2 (error versus correct switch trials) repeated measures ANOVA of alienation ratings yielded a main effect for hand, $F(1,15) = 45.25$, $p < .001$, $\eta^2 = .75$, and a Hand by Error/Correct Switch trials interaction, $F(1,15) = 23.77$, $p < .001$, $\eta^2 = .66$. Follow-up *t*-tests revealed that the attribution of alienation of control to the default hand on error trials was significantly higher than the other three conditions, all *p*s < .001, and well above the mid-point of the scale.

Self control ratings

The mean scores on the self control rating scale for each condition are shown in Fig. 7B. A one-way repeated measures ANOVA comparing self control ratings on correct and incorrect switch trials as well as default trials yielded a significant effect, $F(2,30) = 25.08$, $p < .001$, $\eta^2 = .63$. Follow-up *t*-tests indicated that rated self control was significantly lower following switch errors than under the other two conditions, *p*s < .001. The latter two conditions did not differ.

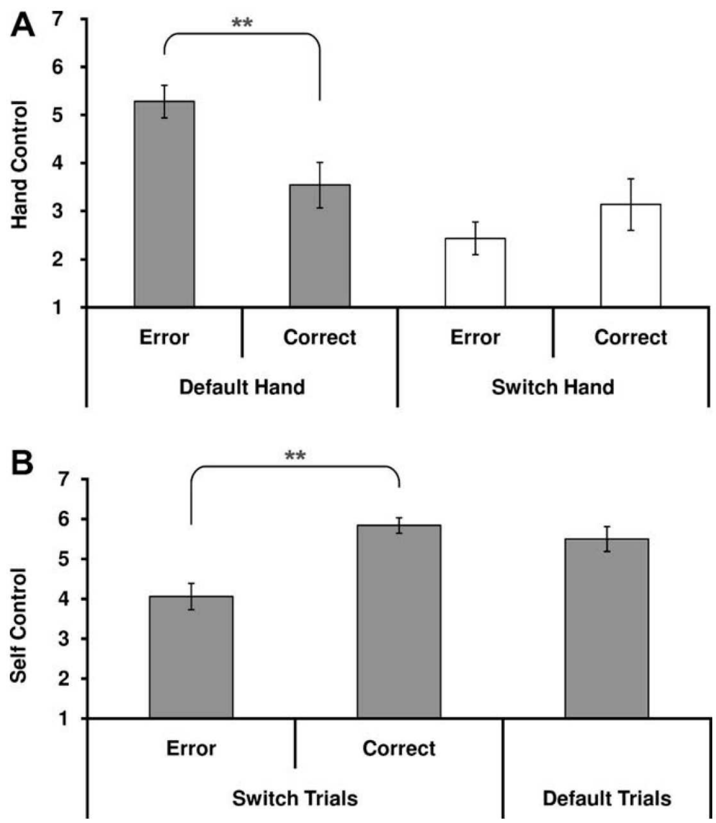

Fig. 7. (A) Experiment 2: means and *SE*s for alienation of hand control ratings following switch trials for default and switch hands (higher scores indicate greater hand control). (B) Experiment 2: means and *SE*s for self control ratings following switch and default trials (higher scores indicate greater self control). $^{**}p < .001$.

Summary

The results of Experiment 2 corroborate our previous conclusion that absent-minded action slips can, in specific circumstances, include the experience that the misbehaving body part has a mind of its own. We found elevated alienation of control for the default hand and that this was specific to error trials. Participants' ratings of alienation of the offending hand cannot simply be taken to mean that they felt their errant responses to be automatic because this would have led to low ratings of both self control and hand control. In contrast, we found that on error trails the default hand was rated low on the self control scale but high on the hand control (alienation) scale.

General discussion

The purpose of the present experiments was to evaluate whether in specific circumstances absent-minded action slips are accompanied by an experience of loss of personal agency and the transfer of the sense of agency to the performing body part. To evaluate this possibility we created the RST, in which the habitual automatic response and the momentarily intended response are manifested by opposing actions of the two hands. We found that during bouts of mind wandering in this task, unwanted errors of commission were accompanied by an alienation of the offending hand. Thus, we were able to create mild and transient attention-lapse induced alienation (ALIA) of agency experiences that appear to be similar to those associated with AHS.

The present findings are consistent with, but do not provide direct evidence for, the hypothesis that similar neurocognitive mechanisms for loss/transfer of agency might underlie both AHS and ALIA. Nonetheless, a review of the separate literatures on AHS and mind wandering attention lapses reveals striking parallels in both cognitive models and neurological correlates discussed in the respective literatures. The prevailing cognitive model for AHS, for example, emphasizes the interaction of controlled and automatic processes (Marchetti & Della Sala, 1998; Norman & Shallice, 1986; Shallice & Burgess,1998). Specifically, AHS is seen as a lateralized failure of the supervisory attentional system to modulate contention scheduling leading to automatic behavior for the anarchic hand. At the same time, independently derived cognitive models for mind wandering have similarly interpreted the involuntary nature of absent-minded action slips as a reflection of a transient loss of executive control over prepotent automatic actions (Smallwood & Schooler, 2006). Consistent with these parallel cognitive theories, the supplementary motor area (SMA), an important area for such executive functions as planning, selecting, resolving conflict, and organizing internally guided behavior appears to be implicated both in AHS (Della Sala et al., 1991; Goldberg, Mayer, & Toglia, 1981; Scepkowski & Cronin-Golumb, 2007) and performance decrements during mind wandering (Garavan, Hester, Murphy, Fassbender, & Kelley, 2006; Hester, Fassbender, & Garavan, 2004). Both of these findings are consistent with compromised SMA functioning (typically unilateral lesions in the case of AHS), which is thought to release from inhibition the more stimulus-driven lateral PFC (Marchetti & Della Sala, 1998). Also highly suggestive is the finding that direct stimulation of SMA in humans elicits complex actions with preliminary feelings of anticipation of, or “urges” for, such movements (Fried et al., 1991).

Automaticity and conflict

Why would the sense of control transfer to the hand in AHS and ALIA? first, according to AHS theory, anarchic experiences result from mismatches between intentions (derived from implicit goals) and outcomes (Frith, Blakemore, & Wolpert, 2000; Marchetti & Della Sala, 1998). It has been noted, however, that is not clear how such mismatches are sufficient for transfer of agency to the hand (Marcel, 2003). Motor disinhibition without denial of agency, for example, is pervasive in neurological conditions and, given that much everyday human action is automatic (Bargh, 1997; Bargh & Chartrand, 1999; Wegner, 2002), one would, guided by such an AHS theory, expect the sense of agency to be constantly challenged in both pathology and in everyday actions. Clearly something else in required. Further parallels between AHS and ALIA may be suggestive here. In both cases, the individual observes an instrumental act of the affected hand not in the absence of feelings of intention, but in the presence of an immediately concurrent, but ineffectual, intention to desist. It is this conflict between intention and action that characterizes both ALIA and AHS.

Merely automatic behaviors are, in contrast, seldom noticed and their fine details are not available to consciousness(Jeannerod, 2003) and, as the opening quotation suggests, they often seem to have access to, even anticipate, our goals. Consistent with this view, Smallwood and colleagues have shown that participants are quite often not aware of their mind wandering unless probed to think about it (Smallwood et al., 2007, 2008). Moreover, automatic actions are generally consistent with concurrent goals – or at least do not interfere with them, as in most absent-minded object manipulation. Experiments providing false feedback produce automatic corrections of movements that, when successful in achieving an explicit goal, are largely ignored (Fourneret & Jeannerod, 1998). Only when automatic movements fail to correct sufficiently to enable goal attainment are they noticed (Jeannerod, 2003; Slachevsky et al., 2001); and what is noticed is the failure to achieve a goal, rather than the details of the motor movements. It is this overt conflict between the intentional goal and what the action achieves, we suggest, that also makes the hand’s actions feel under alien control in the present experimental paradigm; specifically, because of the close proximity of the experience of an (ineffective) executive decision to withhold a response to the“3” on the switch trial and the erroneous automatic response of the default hand.[1]

Thus, in both AHS and ALIA, the salient events are characterized not merely by unintended action but by action explicitly contrary to concurrent perceived intentions. In one case the intended action plan likely does not intervene upon the automatic act because of an underlying lesion and in the other because of the time constraints imposed by the experimental arrangements. In the latter case, the action cancelation comes too late; in the former, it fails altogether. In both cases, the phenomenological outcome is consistent with a violation of a critical requirement for the experience of willed action; namely that intention be consistent with the action and that the actor be aware of the consistency (cf. Linser & Goschke,2006; Wegner, 2002). *The critical ingredient for alienation of agency must therefore be not the mere absence of intention, but a consciously perceived inconsistency between an* *action and a concurrent conscious intention.*

Consistent with the “too-late” ALIA hypothesis, Isoda and Hikiosaka (2007) report that successful performance of rhesus monkeys on switch trials in a cue-switching task was associated with activation of single cells in pre-SMA, but only if this increase occurred before motor response (saccade) initiation. They provide evidence that the delayed increase in activity in pre-SMA neurons was not related to error feedback but represented a “switch signal that was unable to accomplish successful switching” (p. 241). If the cancelation signal comes too late, then consciousness of the cancelation comes still later. Consequently, consciousness intention cannot “play a causal role in triggering action, simply because it comes too late” (Jeannerod, 2006, p. 36). In some cases, however, it is possible that consciousness sometimes comes too late even to monitor and own the action. Finally, the ALIA effect may be enhanced in the present case because of the limited motor involvement and hence minimal proprioceptive feedback normally important for consciousness of action (Jeannerod, 2006; Lafargue, Paillard, Lamarre, & Sirigu, 2003).

Action slips and unconscious “fiddling” actions do not usually lead to any sense of alienation or anarchy on the active body parts because they are typically brought to our attention after completion of the action. Hence we do not experience a concurrent conflict between an occurrent intention and an ongoing activity. Thus, though generally, “slips are in essence amismatch between intention and performance” (Baars, 1992, p. 4) but where the mismatch is detected substantially after the fact. For alienation to occur, the automatic action must, as it were, be caught in flagrante delicto and continue even as we intend otherwise for us imbue it with an alien source.

Limitations and qualifications

In summary, we argue that both ALIA and AHS reflect the failure of the supervisory attention system to modulate contention scheduling leading to the automatic performance of high frequency affordance-driven routines. Such automatic actions are clearly important for the smooth performance of both special tasks and everyday routines without substantial attentional investment. In both cases, the unwanted act is driven by stimulus events that are sometimes appropriate guides, but not during the unwanted act (i.e., in both cases, the acts do not conform to current goals).

There are, of course, significant differences. For AHS, the loss of supervisory control is chronic and relatively enduring (though not necessarily permanent), as well as frequently deeply disturbing to those afflicted. ALIA experiences, in contrast, are extremely transient and, at worst, slightly embarrassing or annoying. The failure of supervisory control for AHS is, at least during the course of the illness, intractable, in that the unwanted behavior persists following its detection. AHS symptoms are clearly lateralized depending on the location of the lesion. In the case of ALIA experiences, the phenomenon is environmentally induced and depends on precisely arranged timing of stimulus onsets and offsets challenging the relatively sluggish performance of the intact and normally functioning supervisory system. Hence, timing is critical as the unwanted act must be completed immediately before the supervisory system becomes engaged. Finally, AHS patients are sometimes reported to show a number of other signs and symptoms, including denial of ownership, personification of the affected body part, intermanual conflict, mirror movements, synkinesis, grasp reflex, magnetic apraxia, and utilization behavior. However, these features are by no means seen in all AHS patients (Scepkowski & Cronin-Golumb, 2007), and some of the cases in which these are reported may actually be suffering from entirely different disorders (Della Sala, 2005). Other features, such as personification, may simply reflect extreme frustration and rather desperate reactions to one’s impotence in the face of the persistence of the unwanted actions. In any case, the only features consistently common to all unambiguous cases of AHS are a perception of the limb movements as beyond the patient’s control and a resulting sense of alienation of the controlling will (Scepkowski & Cronin-Golumb, 2007).

Both similarities and differences are, we argue, instructive. The similarities reveal what is essential to the feeling of alienation of agency, namely a conflict between bodily actions and concurrently perceived intentions. The differences, especially the additional features characterizing AHS, reveal secondary consequences of enduring and persistent loss of control and the sense of agency. Our focus in the present paper has been on the similarities to guide our efforts to isolate the former in order better to understand that elusive and transitory, but critical, experience of being an agent of one’s own actions.

Footnote

[1] Smallwood et al. (2008) have found increased response readiness potential (for what we call the default response) up to six trials prior to an error on the SART. Combined with the performance similarities between our RST and the SART noted in the present experiments, this finding provides support for our claim that the prepotent response conflicts with the updated intention thereby creating an alienation of agency experience in the present task.

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