Consciousness and Cognition 43 (2016) 11–26

Contents lists available at ScienceDirect

Consciousness and Cognition

journal homepage: www.elsevier.com/locate/concog

Simulated thought insertion: Influencing the sense of agency using deception and magic

Jay A. Olson [a,*], Mathieu Landry [b], Krystèle Appourchaux [c], Amir Raz [a,d]

[a] Department of Psychiatry, 1033 Pine Avenue West, McGill University, Montreal, QC H3A 1A1, Canada
[b] Integrated Program in Neuroscience, Montreal Neurological Institute, 3801 University Street, Room 141, Montreal, QC H3A 2B4, Canada
[c] Sciences, Normes, Décision, Université Paris–Sorbonne, Maison de la recherche, 28 rue Serpente, Bureau SE 06, 75006 Paris, France
[d] The Lady Davis Institute at the SMDB Jewish General Hospital, Montreal, QC, Canada

ARTICLE INFO

Article history:
Received 24 October 2015
Revised 17 April 2016
Accepted 25 April 2016

Keywords:
Sense of agency
Thought insertion
Volition
Deception
Magic
Phenomenology

ABSTRACT

In order to study the feeling of control over decisions, we told 60 participants that a neuroimaging machine could read and influence their thoughts. While inside a mock brain scanner, participants chose arbitrary numbers in two similar tasks. In the Mind-Reading Task, the scanner appeared to guess the participants' numbers; in the Mind-Influencing Task, it appeared to influence their choice of numbers. We predicted that participants would feel less voluntary control over their decisions when they believed that the scanner was influencing their choices. As predicted, participants felt less control and made slower decisions in the Mind-Influencing Task compared to the Mind-Reading Task. A second study replicated these findings. Participants' experience of the ostensible influence varied, with some reporting an unknown source directing them towards specific numbers. This *simulated thought insertion* paradigm can therefore influence feelings of voluntary control and may help model symptoms of mental disorders.

1. Introduction

People typically believe that they fully control their thoughts and actions. This belief is often mistaken. People can *feel* control without *having* it, such as when subtle situational factors heavily influence decisions (Olson, Amlani, Raz, & Rensink, 2015; Thaler & Sunstein, 2008). Conversely, they can *have* control without *feeling* it, such as when under hypnosis or when using a Ouija board (Blakemore, Oakley, & Frith, 2003; Gauchou, Rensink, & Fels, 2012). We present a novel method to influence this feeling.

The *sense of agency* refers to the feeling of control over an action or thought. According to recent theories, this sense of agency has two overlapping components: feeling and judgement (Synofzik, Vosgerau, & Newen, 2008). The *feeling* refers to a low-level classification of whether an action is caused by oneself; the *judgement* refers to an analogous higher-level classification. Most theories of agency have focused on the feeling component. The *comparator model*, for example, claims that this feeling arises by comparing the outcome of an action with the initial intention: if they match, one feels a sense of agency (Frith, 2012). Accordingly, people feel more agency over their hand movements while drawing if the outcome of the drawing matches their intention (Synofzik, Thier, & Lindner, 2006).

* Corresponding author.
E-mail address: jay.olson@mail.mcgill.ca (J.A. Olson).

http://dx.doi.org/10.1016/j.concog.2016.04.010
1053-8100/

Some theorists argue that these comparator theories of agency better apply to actions than thoughts (Proust, 2009). If they applied to thoughts, one would have to compare the intention and outcome of a thought, which seems unlikely: one does not intend to have a thought before thinking it (Proust, 2009; Synofzik et al., 2008). Nevertheless, the sense of agency over thoughts varies across situations. When Penfield and Roberts (1976) stimulated the brains of their participants, for example, they reported that thoughts occurred without their control. Further, during pre-sleep states, drug experiences, believed spiritual possessions, and hypnosis, thoughts may seem to originate from an external source (Blakemore et al., 2003; Bourguignon, 1976; Masters & Houston, 1966; Mavromatis, 1987). A theory explaining the sense of agency over thoughts would thus have to account for these situations.

One related theory claims that feelings of agency are strongest when (a) a thought closely precedes the action, (b) is coherent with that action, and (c) is the only apparent cause (Wegner & Wheatley, 1999). The last condition – that the thought must be the only apparent cause of the action – is called the *principle of exclusivity*. This principle may also apply to thoughts: believing in an external source of thoughts may reduce agency. Schizophrenics, for instance, often experience *thought insertion* in which their thoughts seem to originate from a source outside of their own will (Mullins & Spence, 2014). As a result, some schizophrenics conclude there is an influencing machine that can implant their thoughts from a distance (Tausk, 1969).

These distortions in the sense of agency over thoughts can be approximated with hypnosis. Walsh, Oakley, Halligan, Mehta, and Deeley (2015) hypnotised suggestible participants and told them that an engineer would insert thoughts into their heads to complete sentences. When participants heard sentence stems, they reported that other words popped into their heads without their control. In the present feasibility study, we attempted to similarly reduce agency by constructing a plausible external source of thoughts, but without hypnotising participants or stimulating their brains.

Instead, to create this source of thoughts, we used deception, suggestion, and magic. *Mentalism* is a branch of magic that mimics unusual mental phenomena such as telepathy and thought insertion. In the context of a magic show, the audience generally knows these apparent abilities are tricks; in other contexts, they may seem more realistic. Indeed, many students cannot distinguish magic tricks from actual abilities and some believe that neuroimaging machines can read minds (Ali, Lifshitz, & Raz, 2014; Benassi, Singer, & Reynolds, 1980; Swiney & Sousa, 2013). Accordingly, we wanted to use magic to convince people that a neuroimaging machine could influence their thoughts, which would then reduce their sense of agency. Being able to experimentally alter this sense of agency would allow researchers to explore the role of higher-level cognition in feelings and judgements of agency (Gallagher, 2007; Synofzik et al., 2008; Vosgerau & Voss, 2013). It would also demonstrate how much deception and suggestion can affect one's mental experiences.

In this paper, we introduce the *simulated thought insertion* paradigm, which uses deception and magic to influence the sense of agency over thoughts. Study 1 tests whether this paradigm can distort feelings of agency; Study 2 replicates our findings and examines what these distortions feel like experientially. Combined, these studies offer a novel paradigm to study agency by making people believe – and feel – that we are controlling their minds.

2. Study 1: Influencing agency

We introduced participants to a brain imaging machine that could ostensibly influence thoughts. We had three hypotheses. First, when people believe a machine is influencing them, they will report less voluntary control over their mental decisions. Second, this apparent influence will affect the decision-making process, reflected by how quickly people make decisions and how often they change their mind. Third, people who tend to feel that external sources influence their lives (i.e., those with an external locus of control; Duttweiler, 1984) will be more suggestible and thus more likely to feel the influence of the machine (Burger, 1981). In short, we expected that manipulating beliefs would cause distortions in feelings and judgements of agency.

2.1. Methods

2.1.1. Participants

Thirty-seven undergraduate students from McGill University completed the experiment for course credit; after exclusions, 27 participants remained. They were on average 20.5 years old ($SD = 1.8$) and all were female. Most of them majored in psychology (78%) and were in the second year of their studies (50%). We chose our sample size based on a power analysis (see Section 2.1.4) while aiming to run as many participants as possible in Studies 1 and 2 over two months.

2.1.2. Procedure

Participants completed two comparable tasks (Fig. 1) inside a mock neuroimaging scanner. In the Mind-Reading Task, participants chose arbitrary numbers and the machine appeared to guess them. In the Mind-Influencing Task, the machine chose random numbers and appeared to influence participants to choose them. After each task, we measured the participants' sense of agency over their decisions. Because we used a high level of deception, a detailed description of the protocol follows; however, readers can skip it without loss of clarity.

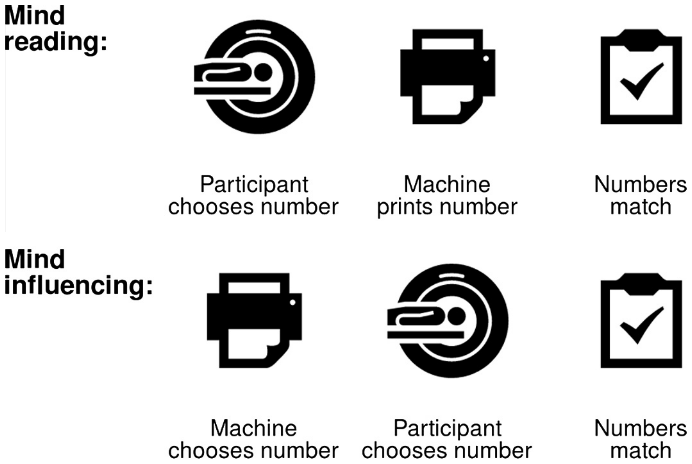

Fig. 1. Overview of tasks. Participants completed 6 trials (3 with feedback) of each task.

2.1.2.1. Briefing (20 min). Each participant met the experimenter (J.O.) at a cognitive neuroscience laboratory in the Montreal Neurological Institute of McGill University. The experimenter asked the participant if she[1] had heard of the Neural Activation Mapping Project (as if it were well-known). He explained that the goal was to "map neural activation patterns onto thoughts and thoughts onto neural activation patterns." First, during "calibration," the participant would think of numbers in the scanner to reportedly map them to her neural activity. The experimenter explained that if this calibration was successful, the participant would complete the Mind-Reading Task. Here, she would silently choose a number while inside the scanner. Based on her brain activity, the machine would then try to infer which number she had chosen. "As you probably know," the experimenter explained, "the machine can only guess the most basic of thoughts: the numbers we calibrated." This phrasing – "as you probably know" – was intended to make the statement appear obvious rather than implausible. Indeed, many participants verbally affirmed the statement.

The experimenter explained that if the Mind-Reading Task was successful, the participant would complete the Mind-Influencing Task. Here, the machine would randomly choose a number. Then, the participant would choose one herself while the machine (ostensibly) tries to influence her to select the pre-chosen number. The machine would accomplish this influence by manipulating the "natural electromagnetic fluctuations in the brain." The experimenter assured the participant that the procedure is safe and has no known side effects. If the participant questioned these fluctuations, the technician would give increasingly complex explanations (of standard fMRI functioning) until the participant stopped asking.

The participant then read the consent form. Three (male) participants thought they would feel claustrophobic in the scanner and discontinued the study (see Table 1).

The rest of the participants completed a "safety screening" questionnaire. It began with demographic information, followed by a subset of an MRI screening questionnaire,[2] then the Internal Control Index (see Section 2.1.3; Duttweiler, 1984). The MRI questionnaire functioned to distract participants from our interest in the Internal Control Index. No participants asked about the latter questionnaire but several mentioned during debriefing that they did not see its relevance.

The experimenter checked the questionnaires as if to ensure the participant passed the screening. He then led her to speak with the technician in the control room. The room contained computers showing images of brain scans (Fig. 2a) to increase credibility (cf. McCabe & Castel, 2008). Beside the computers sat a printer for the machine's output. A monitor above the computers displayed a live video of the adjacent scanner room.

The technician (M.L.) then summarised the tasks that the participant would complete and showed how she would later record her chosen numbers. Namely, she would write her number and sign her initials on the machine's printed output ostensibly to keep an official record of her choices.[3] The experimenter then asked the participant to remove any metals from her person.

The experimenter and participant entered the scanner room, which contained warning signs about the machine's magnet. The room contained a mock MRI scanner (Fig. 2b; Psychology Software Tools, Inc., Sharpsburg, PA).

2.1.2.2. Calibration (10 min). The experimenter then explained the calibration procedure. The participant would concentrate on the number that the technician would announce through the intercom. He told her to stay still during the scan, keep her arms and legs uncrossed, and keep her eyes closed (ostensibly to reduce visual cortex noise).

[1] All participants were female in our final sample; three male participants chose not to begin the study (see Table 1).
[2] This questionnaire came from the Functional MRI Laboratory at the University of Michigan.
[3] In reality, this would later give us a plausible reason to show the participant what number the machine had ostensibly guessed.

Table 1
Sample size and reasons for exclusion.

Number	Note
40	Recruited
−3	Did not begin study due to claustrophobia
=37	Completed experiment
−1	Missed one questionnaire
−3	Knew the experimenter was a magician
−6	Expressed scepticism or partially guessed our hypothesis
=27	Final sample

Fig. 2. Control room (A) and scanner room (B).

The participant reclined on the table and entered the machine. The machine then made a louder noise (a pre-recorded MRI sound) as if it were working. Over the next five minutes, the technician told the participant to think of specific numbers from 1 to 9. He would pause for a variable amount of time between the numbers and would ask her to think of the numbers 4 and 7 again. The variable pausing and occasional repeats were intended to make the calibration process seem more realistic.

2.1.2.3. Mind-Reading Task (10 min). After calibration, the experimenter described the Mind-Reading Task. The participant would think of any two-digit number (i.e., from 10 to 99) that had no special significance to her (e.g., not her birthday or favourite number). The experimenter stressed that she should think of the number as a unit (e.g., 42) rather than as two digits (e.g., 4 and 2).[4] He told the participant she would have 10 s to choose a number inside the scanner. Namely, she would hear a beep, followed by 10 s during which she would choose a number, then another beep, after which she should not change her mind. During the 10 s period, she could change her mind as many times as she wanted. Whenever she thought of a number, or changed her mind about it, she would click a mouse button inside the scanner.

The experimenter then explained that afterwards, the machine would examine her brain recording to infer which number she chose. The technician would view this inferred number and write it on a sheet of paper containing the machine's output, which the experimenter would bring into the scanner room for verification.

To begin the Mind-Reading Task, the participant entered the machine. The technician repeated the instructions then started the recording. The machine made louder noises, then beeped, continued its noises for 10 s while the participant silently chose a number, then beeped again and quieted down.

The participant exited the scanner. After a few seconds, the technician passed a clipboard containing the machine output to the experimenter, who then asked the participant which number she chose. After her response, he showed her the output to reveal which number the machine had guessed (Fig. 3). The guess matched the participant's decision. (Unknown to the participant, the experimenter was a magician and the correct guess was accomplished using a magic trick, described later.) The rest of the output contained technical-looking but nonsensical statistics. The participant wrote her chosen number on the paper, which the experimenter returned to the technician. The technician pretended to examine the output then announced whether more trials were needed.

This process continued for two more trials, during which the participant chose different numbers. As is common in mentalism, to make the procedure look more realistic, the machine made occasional errors (Benassi et al., 1980; Lamont & Wiseman, 2005). Specifically, on the first trial, the machine's number was correct but reversed: if the participant chose 42, the machine would guess 24.[5] "Sometimes it takes a few tries to get it," the experimenter would casually comment.

[4] The same example number (42) was given to all participants in case it served as an anchor to influence later decisions. The experimenter also used 10, 20, and 30 as example numbers when explaining that the participant could change her number.

[5] If she chose two repeated digits (e.g. 44), the guess would be off by two (e.g. 46).

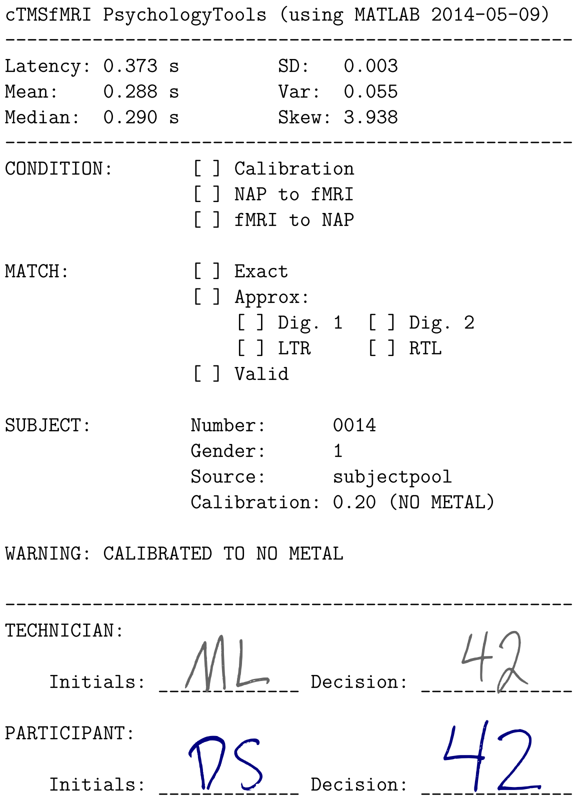

Fig. 3. Fake output from the machine. The participant wrote down her chosen number (bottom) and saw that it matched what the technician had written down.

"Try to think of the numbers as a unit rather than individually," he would suggest, as if her method of concentrating caused the error. While the participant was writing her number, the experimenter notified the technician of the error ("We got a reversal") through the intercom. This delay gave the participant time to examine the output – and the machine's guess – more carefully without having to overtly draw her attention to it. As some performers claim, "When a magician lets you notice something on your own, his lie becomes impenetrable" (Teller, 2012, p. 2).

The magic trick used a common method in mentalism (see Corinda, 1968, "Step One" for a full explanation), though several methods can accomplish the same effect (cf. Rensink & Kuhn, 2014).[6] In essence, whichever number the participant reports ends up appearing as if the machine had guessed it earlier. Importantly, the participant could choose any number she wanted: she was not influenced. The method had a high success rate and failed on only 1 of 162 trials.

When the machine guessed the numbers correctly, participants acted surprised. Several shrieked, some laughed to themselves, many expressed amusement (one stated, "Awesome possum!"), some showed confusion ("Interesting..."), and one expressed discomfort ("I don't like this – this is weird"). Two claimed that it is "like magic"; during debriefing they confirmed they were referring to supernatural magic rather than magic tricks. (None demonstrated knowledge that a magic trick was involved, even during debriefing.) The experimenter validated the participant's amusement but acted as if these results were common and uninteresting.

After three trials with number feedback from the machine, the participant completed three more, during which she stayed inside the scanner.[7] After each trial, she would state her number but would not receive feedback about whether it matched the machine's guess. This lack of feedback made the last three trials preceding the sense of agency measurement identical to the last three of the upcoming Mind-Influencing Task. Thus, any between-task differences in agency were unlikely caused by merely procedural differences between the tasks.

The participant then exited the machine and completed two paper questionnaires while alone in the room. The first questionnaire was a distractor which measured stress during the task. The second measured how much volition and effort par-

[6] Researchers can contact the authors for more details concerning the magic trick.

[7] We used a small number of trials (6) due to time constraints, but this limited the precision of some of our estimates (e.g., reaction time). We also suspected that adding more feedback trials would help participants figure out the deception (cf. Danek, Fraps, von Müller, Grothe, & Ollinger, 2013); however, similar studies have used more or longer trials (Klock, Voss, Weichenberger, Kathmann, & Kühn, in preparation; Swiney & Sousa, 2013) without problematic amounts of suspicion.

ticipants felt during their decisions (see Section 2.1.3). One participant did not complete all of the questionnaires and so was excluded (see Table 1).

2.1.2.4. Mind-Influencing Task (10 min). Next, the experimenter explained the Mind-Influencing Task, in which the machine would select a random number then influence the participant to choose it.[8] At the beginning of each trial, the computer ostensibly generated a random two-digit number which the technician wrote on a sheet of paper in a clipboard. The experimenter brought the closed clipboard into the scanner room in view of the participant. He explained that the participant would again enter the scanner and choose a two-digit number; afterwards, he would check to see if it matched the machine's randomly selected number in the clipboard. The rest of the instructions matched the Mind-Reading Task.

The participant entered the scanner and chose a number. After she exited the machine, the experimenter asked her what number she chose. He then opened the clipboard to check whether it matched the machine's selected number. On the first trial, it was off by two[9]; on the second and third, it matched exactly. Again, the participant could choose any number she wanted, and the matching used the same magic trick as before (Corinda, 1968). After these three trials, the participant would complete three more without receiving feedback. She would then complete the same stress and agency questionnaires as before. The entire procedure took one hour. We call this the *simulated thought insertion* paradigm.[10]

2.1.2.5. Debriefing (10 min). The experimenter led the participant out of the scanner room for debriefing. He asked her how she found the study. The most common responses were "cool" and "interesting." One claimed it was "like X-men." Two reported neutral evaluations ("okay") and none were negative. The experimenter then asked if the participant felt any difference between the Mind-Reading and Mind-Influencing Tasks, which we discuss in the Results (Section 2.2.5).

As a manipulation check, the experimenter then said, "There's something we haven't told you about the experiment yet. Can you guess what it is?" (cf. Mills, 1976). We wanted to exclude participants who doubted whether the task was possible, since we were interested in those who believed the machine could control their thoughts. In total, nine participants showed some suspicion about the task (see Table 1). Three of these were previous students of the experimenter who knew he was a magician and studied deception. The other six showed some suspicion, such as stating that the machine's task was impossible. Our exclusion criterion was likely liberal: some participants may not have been suspicious until we asked. We chose this criterion before looking at the data and the exclusions did not change any decisions about the null hypotheses in the results (cf. Simmons, Nelson, & Simonsohn, 2011).

The experimenter then gave a partial debriefing and explained a complete debriefing would occur after running all of the participants. We continued to conceal the fact that a magic trick was used and that the brain scanner was not functional. After completing data collection we fully debriefed the participants. The experiment conformed to the guidelines of the Jewish General Hospital Research Ethics Committee.

2.1.3. Measures

2.1.3.1. Agency. We were primarily interested in participants' sense of agency during the tasks. We measured it with the Sense of Agency Rating Scale, a paper questionnaire with 7-point Likert scales (Polito, Barnier, & Woody, 2013). We used a 10-item subset of the questionnaire measuring involuntariness and effortlessness (see Table 2 in Polito et al., 2013). *Involuntariness* refers to the amount of internal voluntary control felt over the choice of number (e.g., "I felt that my experiences and decisions were not caused by me"). *Effortlessness* refers to the perceived active effort in the decision, compared to passive absorption (e.g., "My experiences and decisions occurred effortlessly"). We used a modified version of the questionnaire that focused on decisions to make it relevant to the tasks (Polito, personal communication, 2014). The involuntariness subscale usually has high internal consistency reliability (Cronbach's $\alpha = .907$; Polito et al., 2013); it was similar in our sample (.90; Mind-Reading: .83, Mind-Influencing: .88). Effortlessness usually has lower reliability (Cronbach's $\alpha = .734$); it was substantially lower in our sample (.47; Mind-Reading: .36, Mind-Influencing: .54). The latter reliability is insufficient by most guidelines (Peterson, 1994) so we avoid drawing strong conclusions about effortlessness.

2.1.3.2. Response time and choice. Our secondary dependent variables were response time, number choice, and how many decisions were made during the number selection (i.e., how often participants changed their number each trial). Participants clicked a button when they chose a number and each time they changed their mind about it during the 10-s window of number selection inside the scanner. The response time was the duration between the machine's initial recording beep (signalling that the participant should choose a number) and the last button press of the trial.

2.1.3.3. Locus of control. We had one predictor variable, *locus of control*, which represents how much the participant believes that her actions control her life situation (Rotter, 1966). We measured locus of control with the Internal Control Index (Duttweiler, 1984), a 28-item paper questionnaire. An example item is: "If I want something I always work hard to get it." Higher scores (up to 140) indicate an internal locus emphasising responsibility and autonomy; lower scores (down to

[8] The order of the two tasks was counter-balanced across participants.

[9] Or, if the number was off by two in the first trial of the Mind-Reading Task, the guessed number would be reversed. Restated, the machine's number in the first trial of each task would be incorrect in different ways (viz. off by two or reversed).

[10] We avoid the unfortunate acronym "STI".

28) indicate an external locus emphasising luck and fate. The scale has fairly high internal consistency reliability (Cronbach's $\alpha = .84$; Duttweiler, 1984); it was similar in our sample (.90). Participants had an average Internal Control Index of 104 ($SD = 13.26$, range: 69–125), which is expected for their age group and education level (Duttweiler, 1984).

2.1.3.4. Stress. Before the Sense of Agency Rating Scale, participants completed the plausibly relevant Short Stress State Questionnaire as a distractor (post-questionnaire items 1–10 in Helton & Näswall, 2014). Participants felt relaxed during the task with an average stress score of 1.53 out of 5.

2.1.4. Analysis

Our main analysis involved the questionnaire data. Since we had a repeated-measures design, we tested for mean between-task differences in involuntariness and effortlessness with paired-sample *t* tests. Given the results of similar studies looking at self-reported changes in control (e.g., Blakemore et al., 2003; Walsh et al., 2015), we expected large effects (Cohen's $d \approx 1$). With an α of .05, we had the statistical power to detect differences of at least 0.65 standard deviations 90% of the time. For effect sizes we used d_R, a robust version of Cohen's *d*, which quantifies mean differences in standard deviations.[11]

To test whether locus of control predicted differences in involuntariness or effortlessness, we checked for non-linearity then did a Pearson's *r* test. Given our sample size, we had the statistical power to detect only large correlations ($r \geqslant 0.57$) 90% of the time.

Our secondary analysis examined response times and number choices. We compared the median response times across tasks using the Wilcoxon–Mann–Whitney test, since the distributions were skewed. We excluded trials in which participants received feedback, leaving three trials per task per participant (162 trials in total). We compared the decision count between the tasks using Poisson regression. In particular, we tried to predict the number of times participants pressed the button (signalling that they chose or changed their number) each trial given the task condition. With the low number of trials, we did not have high statistical power for this test. Finally, we simply plot and describe the number choices themselves. All assumptions were reasonable for the tests conducted,[12] and all tests were two-tailed.

The analyses used R 3.2.4 (R Core Team, 2015), with packages bootES 1.2 for effect sizes and their bootstrapped confidence intervals (Kirby & Gerlanc, 2013), Hmisc 3.17-2 for bootstrapped confidence intervals of raw variables, coin 1.1-2 for the Wilcoxon–Mann–Whitney test (Hothorn, Hornik, van de Wiel, & Zeileis, 2008), and ggplot2 2.0.0 (Wickham, 2009) for graphs.

2.2. Results and discussion

2.2.1. Involuntariness

We predicted that people would feel less control over their thoughts when they believed they were being influenced. As predicted, the involuntariness in the Mind-Influencing Task ($M = 16.04$ [13.26, 18.67])[13] was higher than in the Mind-Reading Task ($M = 9.07$ [7.52, 11.11]; Fig. 4a). The majority (81%) of participants showed this pattern. The mean difference score was $d_R = 0.84$ [0.53, 1.48] standard deviations ($t_{26} = 4.44, p < .001$). This large effect is consistent with the principle of exclusivity (Wegner & Wheatley, 1999): people feel less voluntary control when there is a plausible external source of the thought. The Mind-Influencing Task involuntariness scores ($M = 16.04$) resembled those of medium hypnotisable participants under hypnosis ($M = 18.83$), but were lower than those of high hypnotisable participants ($M = 23.56$) or schizophrenic patients ($M = 23.26$; Polito, Langdon, & Barnier, 2015).

2.2.2. Effortlessness

We also predicted that people would feel relatively effortless when choosing numbers in the Mind-Influencing Task. Here we saw little difference: the average effortlessness in the Mind-Influencing Task ($M = 28.37$ [26.63, 29.89]) resembled that of the Mind-Reading Task ($M = 29.74$ [28.48, 31.04], $t_{26} = -1.67$, $p = .11$, $d_R = -0.32$ [−0.72, 0.05]; see Fig. 4b). The effortlessness differences were unrelated to the involuntariness differences ($r_{25} = .01$ [−.38, .42], $p = .96$). Recall that the low reliability of the effortlessness measure makes it difficult to draw conclusions here.

2.2.3. Decision

We were also interested in whether participants would differ in their decision process, including their response time, how often they changed their mind about the numbers, and which numbers they chose. Participants took longer to choose their number in the Mind-Influencing Task ($Mdn = 5.77$ [5.18, 6.38] s) than in the Mind-Reading Task ($Mdn = 3.73$ [3.35, 4.62] s; see Fig. 5a). The median difference was 1.83 [1.01, 2.7] s (Wilcoxon–Mann–Whitney $z = 4.07, p < .001$). This slower response time may indicate that the decisions felt less fluent. Indeed, several studies have found a negative correlation between the sense of agency and the feeling of fluency during a decision (Chambon, Sidarus, & Haggard, 2014). An exploratory analysis

[11] It equals the 20% trimmed mean divided by the 20% Winsorised standard deviation (Algina, Keselman, & Penfield, 2005).

[12] The involuntariness and effortlessness distributions may not appear to meet the assumption of normality, but the distributions of their difference scores do, which we used in our tests. For simplicity we plot the original variables rather than the difference scores.

[13] Square brackets throughout denote bootstrapped 95% confidence intervals (Cumming, 2014; Kirby & Gerlanc, 2013).

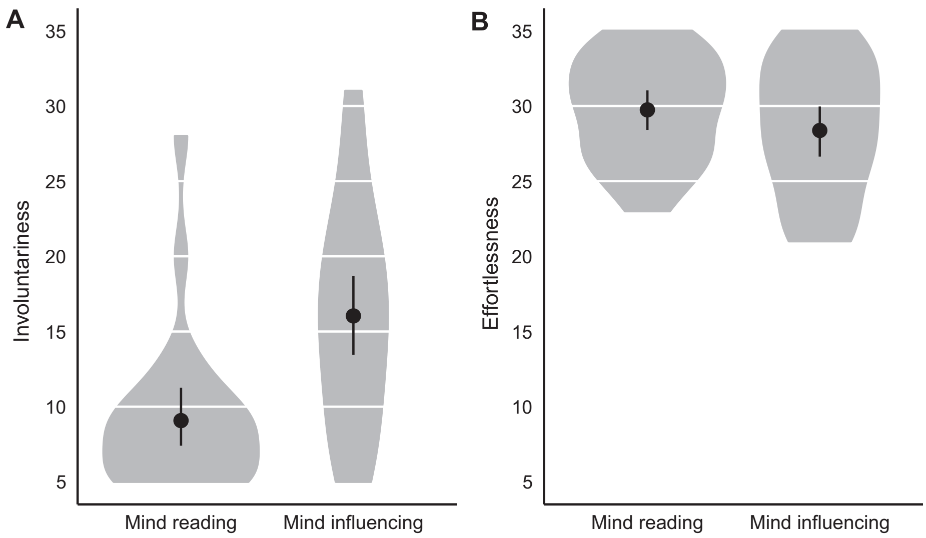

Fig. 4. Involuntariness (A) and effortlessness (B) ratings by task. Dots show means, width shows frequency, and error bars show 95% bootstrapped confidence intervals.

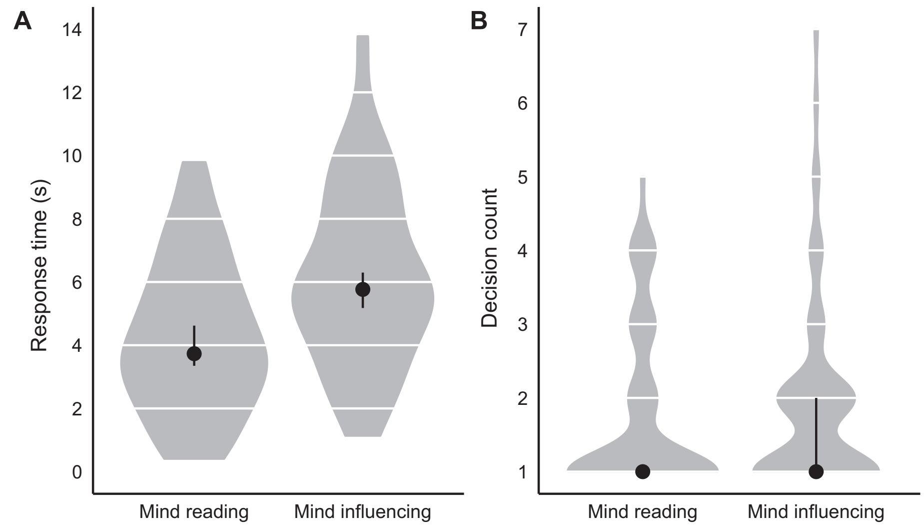

Fig. 5. Response time for last number choice (A) and count of numbers chosen (B) in each trial by task. Dots show medians, width shows frequency, and error bars show 95% bootstrapped confidence intervals.

revealed similar correlations here. People who took longer to respond reported increased involuntariness ($r_{49} = .34$ [.11, .53], $p = .02$; Fig. 6a) and decreased effortlessness ($r_{49} = -.40$ [−.60, −.17], $p = .003$; Fig. 6b).

People changed their mind the same number of times during each task (Fig. 5b; Poisson regression $z = 0.59$, $p = .56$, odds ratio = 1.07). The median count of numbers chosen each trial was 1.

Participants also demonstrated biases towards particular numbers. They tended to choose numbers beginning with 4s (Fig. 7a), perhaps due to the example number given (42) which may have served as an anchor. Indeed, 42 seemed to be a relatively common number on later trials. Perhaps participants tried to suppress that number at first, then it later rebounded (cf. Wegner, 1994), or they simply forgot it was mentioned but it remained primed. Participants also tended to choose smaller numbers, perhaps because all of the example numbers mentioned during the briefing were smaller ones (viz. 10, 20, 30, and 42). For the second digit, people commonly chose 7s and 3s (Fig. 7b). These digits are commonly named when asking people to choose a number (Kubovy, 1977; Kubovy & Psotka, 1976; Olson, Amlani, & Rensink, 2012). Overall, the most common selections were 17 and 19 (each chosen 6 times).

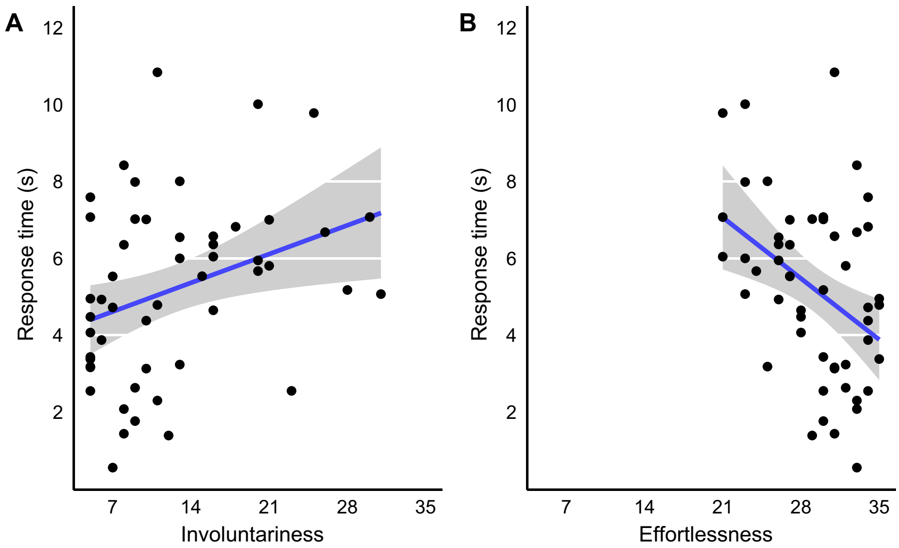

Fig. 6. Correlations between involuntariness (A, $r = .34, p = .02$), effortlessness (B, $r = -.40, p = .003$), and response time for number choice, across both tasks. Dots show averaged response times for each participant and task. Band shows 95% confidence interval.

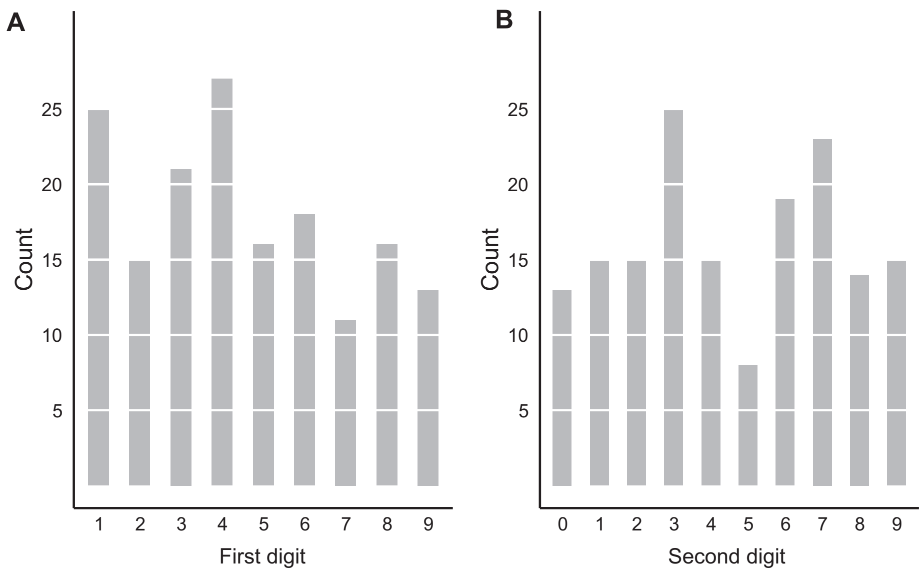

Fig. 7. First (A) and second (B) digits in number choices across both tasks.

2.2.4. Locus of control

We also expected that locus of control would predict differences in involuntariness and effortlessness between the tasks. Participants with a more external locus of control (i.e., lower Internal Control Index scores) may be more suggestible (cf. Burger, 1981) and may thus experience larger differences between the tasks. Alas, there were no such relationships between locus of control and differences in involuntariness ($r_{25} = .23$ [$-.07, .64$], $p = .25$) or effortlessness ($r_{25} = .17$ [$-.21, .43$], $p = .41$).

2.2.5. Experience

Just before debriefing, we asked participants if they "noticed any difference between the tasks". Most of them (72%, $n = 18$) did. Only in the Mind-Influencing Task, some participants mentioned unusual experiences. One reported that she did not choose the numbers: they "just came" to her. Another stated that her eyes "waved back and forth rapidly" as if "scanning through many numbers" then stopped when she had one. During pilot testing, one participant said that she had a throbbing headache during the Mind-Influencing Task, perhaps from the machine. After giving her a full debriefing of the deception, she reported that the headache suddenly disappeared. These reports motivated us to explore participants' experiences with more precision in Study 2.

3. Study 2: Replication and qualitative analysis

Having established that we can distort the sense of agency over thoughts, we wanted to replicate these findings (cf. Open Science Collaboration, 2015) and examine the subjective experience associated with the distortions. Few researchers have studied the phenomenology of agency and its relation to behavioural data (Appourchaux, 2014; Vosgerau & Voss, 2013). Here, we attempted to complement the results of Study 1 with descriptions of what participants were thinking and feeling while inside the scanner. We used the *elicitation interview* which aims to gather first-person descriptions of experience (Vermersch, 1994). This technique emphasises the procedural aspects of the experience (the "how") rather than evaluations or theoretical knowledge about it (the "why"). In doing so, it attempts to reduce post hoc rationalisations which are common when explaining decisions (Johansson, Hall, Sikström, & Olsson, 2005; Nisbett & Wilson, 1977; Petitmengin, Remillieux, Cahour, & Carter-Thomas, 2013). As such, this interviewing technique is well-suited for exploring what participants think and feel throughout the decision-making process.

3.1. Methods

3.1.1. Participants

Twenty-three undergraduates completed the experiment for course credit; after exclusions, 20 participants remained. They were on average 20.4 years old ($SD = 1.8$) and most were female (85%). Many of them (45%) majored in psychology and were in the second (45%) or third year (45%) of their studies. The sample thus resembled that of Study 1.

3.1.2. Procedure

The procedure mirrored Study 1 except that we interviewed participants about their experience. After each task, the interviewer (K.A.) entered the scanner room. The interviews began with the suggestion that the participant recall sensory cues, such as the technician announcing the last trial and the machine's beep, to help re-live the experience of the previous decision in detail. This technique helped the participant reach an *evocation state* in which the experience of choosing a number would become more salient and easier to recall (Vermersch, 1994). The interviewer would then ask participants to describe their experience. The questions were "content-free" in that they offered little information and instead prompted the participant to continue describing the experience:

> Interviewer: I'm going to suggest that you take a little time to go back to the moment when you made your choice.
> Participant: ... One number popped in and that was ... in my head and I just couldn't change it. Before [in the Mind-Reading Task], I would go between [numbers], but [this] one ... I just didn't change, I just kept thinking about it.
> I: Okay, so, if we go back to the first beep, when you hear the first beep, what happens next?
> P: I couldn't think of any number, and then ... it took maybe two seconds and then the number came. And then 71 popped in, and then it just stayed.
> I: Okay, so two seconds, then the number 71 pops in. How does it manifest itself?
> P: It just ... appeared, like I could see ... the number.

Each interview was recorded and lasted from 3 to 12 min ($M = 6$ min). After the interview, participants completed the same questionnaires as in the previous study.

We excluded three participants using the same criteria as in Study 1. One participant knew the experimenter was a magician and two were suspicious about whether the task was possible. In addition, we excluded a fourth participant from the interview analysis alone due to a malfunction during recording. As in Study 1, none of the exclusions changed the decisions about the null hypotheses.

3.1.3. Analysis

We ran two analyses. First, we tested the same hypotheses as in Study 1: namely, in the Mind-Influencing Task, people would feel less agency, make slower decisions, and change their mind more often.[14] Second, we did an exploratory thematic analysis of the interview data without any *a priori* themes (Joffe, 2012). This analysis began with transcribing the interviews then looking for recurring themes, of which we found 33 (see Table A1). We gave the list of themes to four blind judges who independently ascribed them to each participant response in the transcripts. For each participant response, we kept only the themes that at least half of the judges agreed upon (without deliberation). After coding the interviews, we compared the frequencies of the themes between the two tasks. Finally, we searched the transcripts for atypical experiences that may not have been captured by assigning individual themes.

[14] We did not statistically compare the results of Study 1 and Study 2 for two reasons. First, we lacked statistical power to detect probable differences (viz., small or medium effects). Second, even if we did detect differences, we could not determine if they were caused by the presence of the interviews or trivial changes in the procedure (e.g., more time between the number decisions and questionnaires in Study 2). In any case, the results of the two studies were similar (see Fig. 8).

3.2. Results and discussion

3.2.1. Behaviour

Most of the results resembled those of Study 1 in direction and magnitude (see Fig. 8). Participants felt their decisions were more involuntary in the Mind-Influencing Task ($M = 19.4$ [16, 22.75]) compared to the Mind-Reading Task ($M = 10.35$ [7.95, 12.75]; Fig. 9a) and the effect size ($d_R = 0.95$ [0.61, 1.9]) was similar to that of Study 1. These involuntariness scores again resembled those of medium-hypnotisable participants (Polito et al., 2015). Participants made slower decisions in the Mind-Influencing Task (by 1.65 s; Fig. 9c) and changed their mind as frequently in each task (Fig. 9d). There were no correlations between locus of control and agency measures (Fig. 8). Participants again chose lower numbers (Fig. 9e) but, unlike in Study 1, this time they seemed to show a preference for even numbers (Fig. 9f).

Unlike in Study 1, participants may have felt more effortless in the Mind-Reading Task ($M = 30.1$ [28.75, 31.6]) than in the Mind-Influencing Task ($M = 28.1$ [26.7, 29.55]; $d_R = -0.72$ [−1.28, −0.09]; Fig. 9b). However, the reliability of effortlessness was low so it is difficult to draw conclusions (Cronbach's $\alpha = .42$; Mind-Reading: .61, Mind-Influencing: .20). The reliability measures of involuntariness (.92; Mind-Reading: .81, Mind-Influencing: .92) and locus of control (.84) were adequate.

3.2.2. Interviews

The most common themes reflected what people visualised, heard, or thought of while choosing their numbers (Table A1). The only major difference between the tasks seemed to be how often participants explained the strategy behind their selections. Although the interviewer never asked why they chose their numbers, in the Mind-Reading Task, more participants provided spontaneous explanations (74%, $n = 14$) than in the Mind-Influencing Task (16%, $n = 3$). In the Mind-Reading Task, some ($n = 8$) mentioned choosing a number different from previous selections, such as a number in the 80s because the participant had not "chosen 80-something in a while." Others ($n = 3$) described the associations with their numbers, such as choosing 52 "as in 52 weeks in a year" or a number close to the participant's age. One chose 78 because it was a "good, strong number." Two others reported choosing the first or last numbers that came to mind.

These reasons contrasted with the few explanations given in the Mind-Influencing Task. One participant reported wanting to choose a different number than before; one felt there was nothing "trying to distract [him] from this number"; and one chose the last number that came to mind. This difference in explanations between the tasks is consistent with theories of agency. Being able to construct a coherent narrative explaining a decision may correlate with agency judgements (Synofzik et al., 2008; Vosgerau & Voss, 2013). Given that the elicitation interview aims to reduce post hoc rationalisations, this difference in explanations may reflect different cognitive strategies used to choose the numbers. Indeed, in the Mind-Reading Task, an exploratory test showed that those who explained their decisions took longer to choose than those who did not ($Mdn_{diff} = 1.65$ [0.33, 2.85] s).

There were also unusual experiences. In the Mind-Influencing Task, participants reported a variety of agency-related phenomena. Some claimed that the decision did not feel like it was their own: "It didn't really feel like I was making the choice – it kind of just happened." Another reported, "I kind of felt like [the number] came out of nowhere. So I felt like it … wasn't my choice. I don't know why I chose it." Others claimed they could not change the number: "I thought about trying to change [the number], but then … it doesn't." Another agreed: "I almost can't think of another one."

Some reported feeling that the number came from a source beyond their control. Sometimes the source was the participant's apparently disobedient brain. One claimed, "I was going … with 34, but my brain just told me no, that's not the number, so I went…: 32, 33, 31, 30." Another felt that "it's almost like my brain is shuffling through numbers until it … stuck to one." Some suggested the source was the machine: "I can't put my finger on it – it's just like … once the magnet turned on … I got 4, and then I got 7…" For others, the source was unknown: "I felt like I was drawn to [the number]." Another said, "it really just felt like [the number] kind of came to me [from] somewhere else." One participant claimed:

> I feel like it's a voice … dragging me from the number that already exists in my mind. I … feel some kind of force, or some kind of … image, or [something] trying to distract me from this number, and then I form [another] number.

Some participants also felt unusual sensations. One commented, "I pretty much felt like it was in my brain, … I really noticed a kind of a pulsation, … almost physical." Another noted, "I don't know why but my face feels really hot, like my head is really hot, but the rest of my body doesn't feel anything." In contrast, participants reported almost no unusual experiences or sensations in the Mind-Reading Task.

These results match a model of thought insertion which claims that normal thoughts with a reduced sense of agency may feel like inserted ones (Humpston & Broome, 2015). These thoughts often co-occur with "delusional elaboration," in which the person tries to identify the source of the thoughts. Similarly, with a reduced sense of agency, some of our participants provided unusual explanations regarding the source of the number decision (see also Swiney & Sousa, 2013). Our paradigm may thus offer a novel way to test these theories of agency.

The apparent differences in experience between the two tasks may have been complicated by participants' intuitive metaphysics. Rose, Buckwalter, and Nichols (2015) found that when people read stories about machines that can predict and influence behaviour, they still interpret these scenarios with the assumption of a free will. In the present study, when participants *experienced* such scenarios, their probable assumption of a free will may have biased their interpretations and

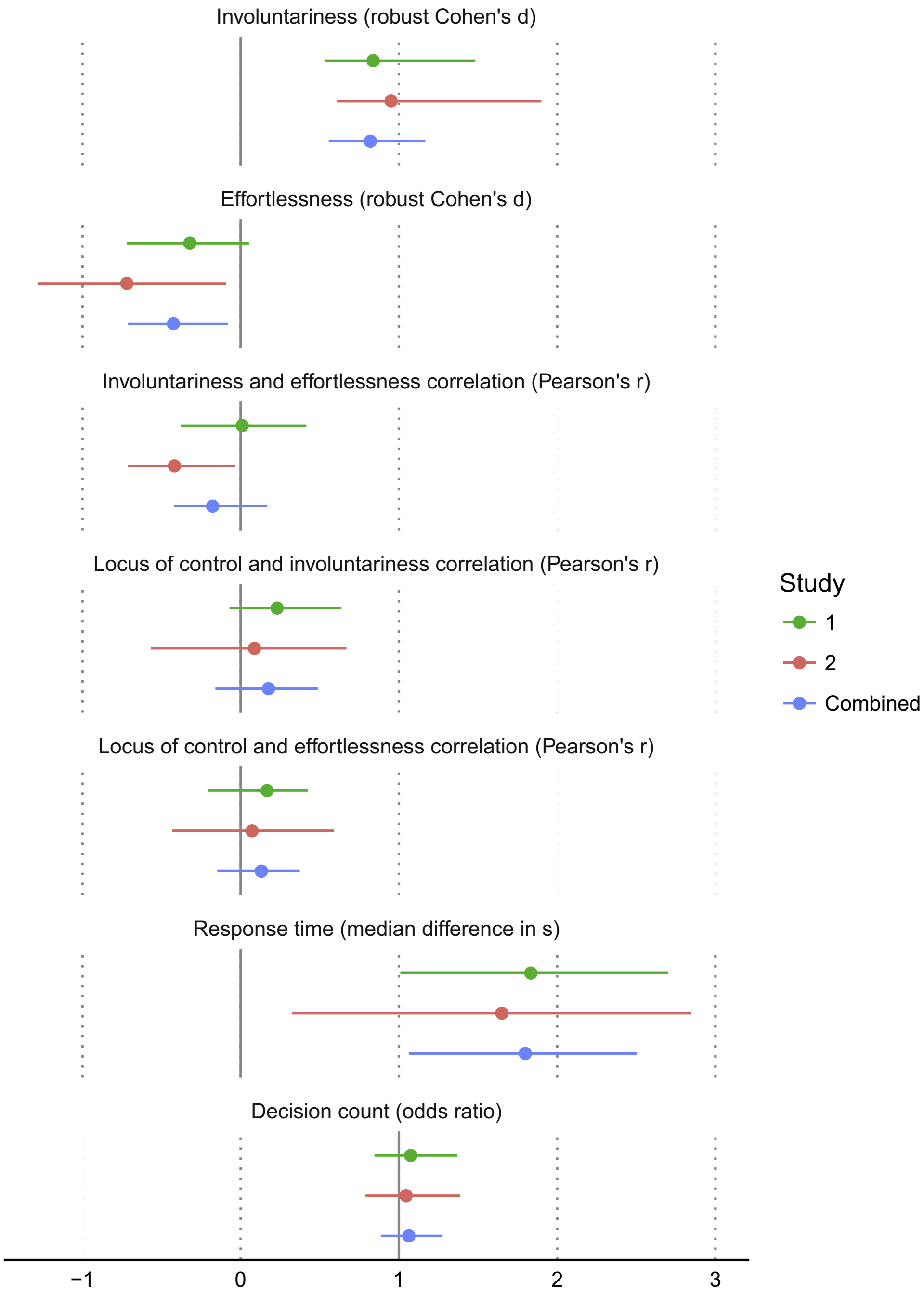

Fig. 8. Mind-Influencing (compared to Mind-Reading) Task effect sizes between studies. The only inconsistencies between studies involved effortlessness, which had low reliability. Solid vertical lines show null-hypothesised values and error bars show 95% confidence intervals (bootstrapped except for Decision count and Response time). Correlations of involuntariness and effortlessness refer to between-task differences, not the original variables. For the robust Cohen's *d*, see Algina et al. (2005).

reports. These individual differences may partly account for why some participants reported little difference between the tasks while others reported unusual experiences such as voices influencing their decisions.

This exploratory study had several limitations. First, the interviews may have affected participants' subsequent questionnaire responses, for example by making them more prone to introspection (cf. Petitmengin et al., 2013). The results may therefore be less reliable than those of Study 1. Second, our small sample size prevented us from categorising participants based on their decision-making strategies or experiences (cf. Lutz & Thompson, 2003). Overall, in this study we were again able to influence feelings of agency, but people experienced these influences in a variety of ways.

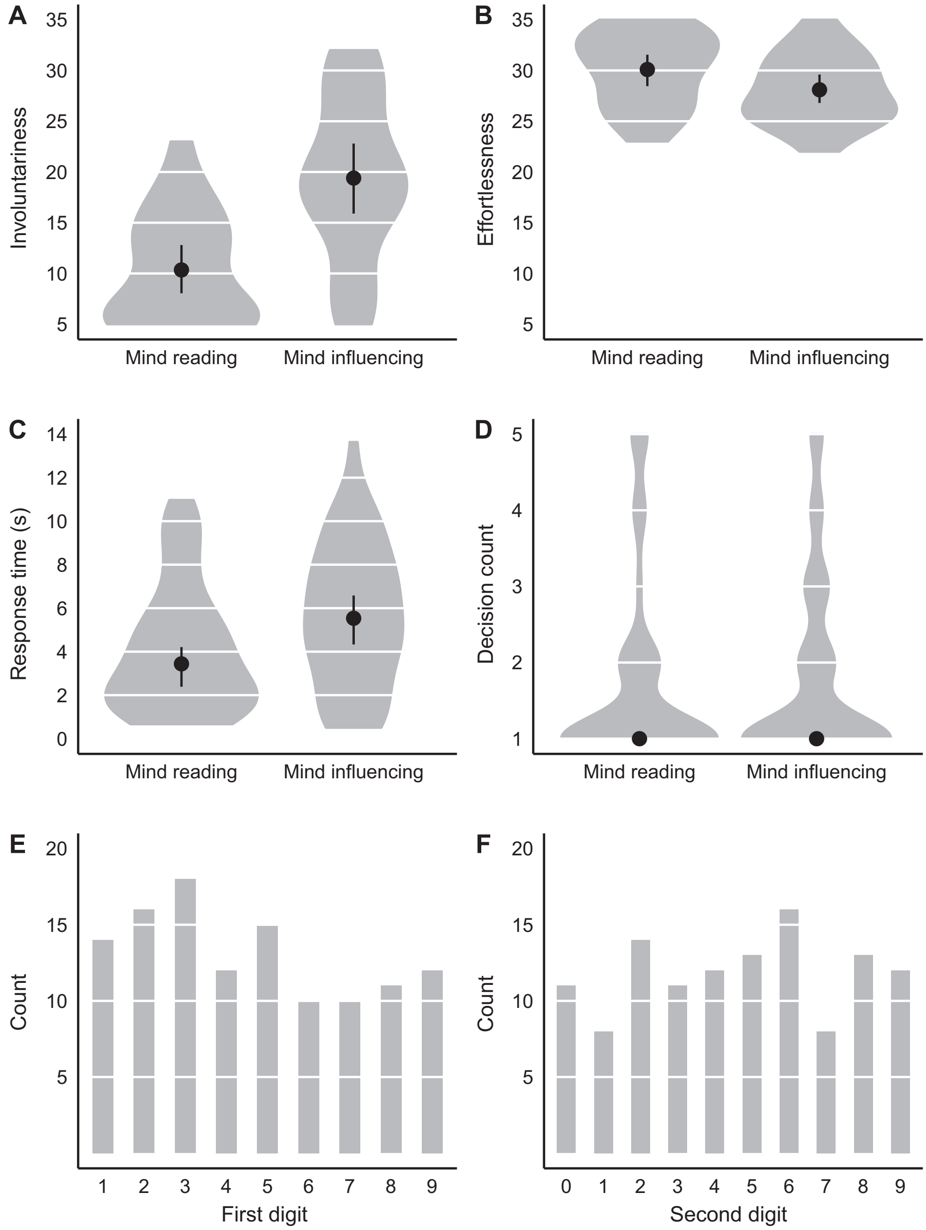

Fig. 9. Study 2 results. Involuntariness (A) and effortlessness (B) ratings by task, response time for number choice (C) and count of numbers chosen (D) in each trial by task, and first (E) and second (F) digits in number choices across both tasks. Compare to Figs. 4, 5 and 7.

4. General discussion

We introduced and tested the simulated thought insertion paradigm, in which we convinced people that a machine was controlling their thoughts. In doing so, we were able to distort their sense of agency and slow their decision-making process. Their experience of the illusory influence varied, with some reporting a voice or unknown source directing them towards a particular choice.

Our findings demonstrate the potency of top-down influences on feelings of agency. Here, participants chose arbitrary numbers after we altered their beliefs about the source of the choice (viz. self-chosen or machine-chosen). Consistent with theories of agency, this change in belief affected the fluency of the decisions (as seen by response time; Chambon et al., 2014), the narratives used to explain them (Bayne & Pacherie, 2007; Synofzik et al., 2008), and the feelings of voluntary control over them.[15]

[15] The data sets (questionnaires, response times, and number choices) are available online at https://osf.io/uc73j/.

These results add to the body of evidence suggesting a double dissociation between the sense of agency and actual agency: between the feeling of control and actual control (Wegner, 2003). Consistent with other studies (e.g., Hall, Johansson, & Strandberg, 2012; Johansson et al., 2005), we have previously shown that people can feel control over their decisions without having control (Olson et al., 2015); the present study demonstrates that people also can have control without feeling it. Our paradigm offers a novel way to study this puzzling dissociation.

More generally, this paradigm demonstrates the usefulness of magic in experiments. Researchers have previously used magic as a tool to study suggestion (Wilson & French, 2014), decision-making (Johansson et al., 2005), attitude change (Hall et al., 2012), and beliefs (Subbotsky, 2004). In our paradigm, magic allowed us to *simulate* thought insertion and to demonstrate that this procedure worked. Without it, participants likely would have had less confidence in the procedure (cf. Swiney & Sousa, 2013) which may have reduced our effects.

Paradigms similar to ours have been used to model symptoms of mental disorders. For example, researchers have used hypnosis to create the appearance of delusions such as thought insertion in healthy individuals (Connors, 2015; Walsh et al., 2015; Woody & Szechtman, 2011). This method enables researchers to explore such symptoms with a high level of control in more accessible populations (Connors, 2015). Our study demonstrates that some of these symptoms can be partly reproduced with magic tricks rather than with hypnosis. Given that mentalism magic provides the illusion of several unusual mental abilities central to many delusions (e.g., telepathy, psychokinesis, clairvoyance), using magic to simulate these delusions could help model symptoms of mental disorders. This method has several benefits over using hypnosis: it removes the need for time-intensive hypnosis screening and may be more effective on a larger proportion of people.[16] However, our paradigm may produce weaker or shorter effects than hypnosis with highly hypnotisable participants (cf. Polito et al., 2015), may be less effective on suspicious individuals, and requires expertise in magic. Further, it is currently unclear whether related paradigms can generalise to thoughts beyond numbers or words (Klock et al., in preparation; Swiney & Sousa, 2013).

Our study had other limitations involving experimental control. First, although we compared results between tasks, we did not have a separate control task; for example, we could have had participants choose numbers while the machine was turned off. We assumed that the Mind-Reading Task would not affect agency and therefore could serve as a baseline; as such, we excluded a separate control task, which limited some of our conclusions. Second, we could not isolate the causal role of the magic trick compared to the rest of the deception. Future studies could contrast these by presenting the deception without the magic trick and vice versa. Comparing these conditions would help isolate the source of the changes in agency. Third, perhaps the largest limitation of the study is that participants may have inferred that we were looking for differences between the two tasks and responded accordingly. We attempted to reduce this possibility by giving a cover story, using distractor questionnaires, excluding suspicious participants liberally, and measuring different kinds of variables (subjective and objective). The response times in particular may have been less susceptible to demand characteristics given that we lacked directional predictions about them; participants could not have inferred our hypotheses here and behaved accordingly. Nevertheless, we still saw differences in response times in a consistent direction. Given that we examined how beliefs about the task affect agency, it would have been implausible to reduce demand characteristics by keeping participants blind to their task condition. Indeed, the goal of the paradigm was to create a context in which participants would knowingly disown their thoughts and attribute them to a machine.

Our paradigm opens several possibilities for research. If people believe a machine can read their minds, would they more likely tell the truth in a scanner? If people believe it can influence thoughts, would they also believe – and experience – ostensibly implanted feelings or judgements? Do people feel different levels of agency based on the content or emotion of these implanted thoughts (Swiney & Sousa, 2013)? Does simulated thought insertion reduce people's belief in free will and change their attitudes or behaviour (cf. Vohs & Schooler, 2008)? By adapting established techniques from magicians and deceivers, we hope to enable new experimental methods that can answer these questions. In doing so, we aim to uncover why people so strongly feel that they control their thoughts and actions – even when they do not.

Acknowledgements

We would like to thank Ilan Goldberg for helping with the design; Josh Laxer and Moriah Stendel for transcribing the interviews; Jason Da Silva Castanheira, Kylar D'Aigle, Madalina Prostean, and Léah Suissa-Rocheleau for coding the interviews; Angela Shen for entering data; Mélanie Bolduc for taking the photos; and Patrick Haggard, Leonie Klock, Michael Lifshitz, Mark Mitton, Claire Petitmengin, Anne Remillieux, Ronald Rensink, Diana Sitoianu, Thomas Strandberg, and three reviewers for helpful comments.

J.O. acknowledges the Joseph-Armand Bombardier Scholarship from the Social Sciences and Humanities Research Council of Canada, and funding from the Bial Foundation and the Desjardins Foundation; M.L. acknowledges the Alexander Graham Bell Canada Graduate Scholarship from the Natural Sciences and Engineering Research Council of Canada (NSERC); and A.R. acknowledges the Canada Research Chair program, Discovery and Discovery Acceleration Supplement grants from NSERC, and Canadian Institutes of Health Research.

[16] Future studies, though, may benefit by screening participants for schizotypy or mental disorders; simulated thought insertion might be uncomfortable for some individuals. We had not thought of this concern before conducting the study and our sample showed no signs of distress.

Appendix A. Interview themes

Table A1 lists the interview themes.

Table A1
Interview analysis themes, descriptions, and percent of participants reporting them in each task. Only the "Strategy" theme seemed to show a large difference.

Theme	Description	Mind-Reading %	Mind-Influencing %
See	Saw the number (in mind's eye)	74	84
Strategy	**Explained the reason or strategy for the number choice**	**74**	**16**
Repeat	Thought of number over and over	63	58
Say	Said number in head	63	58
Hear	Heard number in head	58	37
Multiple	Thought of more than one number	53	74
Happened	Number choice "just happened" seemingly on its own	47	53
Digits	Chose or thought of the two digits separately	42	37
Fast	Number quickly came to mind	42	37
Own	Felt like participant's own decision	42	26
Colour	Mentioned the colour of the number	37	53
Flip	Number rapidly changed or "flipped by"	37	32
Appeared	Number just appeared or popped in head	37	26
One	Thought of only one number	37	26
Feel	Mentioned what it felt like whilst choosing the number	32	42
Random	Chose the number randomly	32	32
Focus	Tried to concentrate on the number	32	21
Uncertain	Did not feel certain about the number	32	21
NotSee	Mentioned not seeing the number	32	16
Stuck	Number stuck in the head or was hard to change	21	26
Write	Thought of or visualised writing the number	21	21
Slow	Number slowly came to mind	16	26
Right	Wondered whether number matched machine's	16	16
Easy	Choice felt easy	16	5
Brain	Mentioned the brain	11	16
NotOwn	Did not feel like own choice	11	16
Pattern	Numbers followed a pattern (e.g., increasing)	11	16
Suggestion	Thought she felt something because we told her to	11	5
Certain	Number choice felt certain	5	11
Confused	Seemed confused	5	5
Suspicious	Seemed suspicious about the experiment	5	5
Bold	Number visually appeared thick or bold	5	0
Body	Mentioned a bodily sensation	0	16

References

Algina, J., Keselman, H. J., & Penfield, R. D. (2005). An alternative to Cohen's standardized mean difference effect size: A robust parameter and confidence interval in the two independent groups case. *Psychological Methods, 10*(3), 317–328. http://dx.doi.org/10.1037/1082-989X.10.3.317.

Ali, S., Lifshitz, M., & Raz, A. (2014). Empirical neuroenchantment: From reading minds to thinking critically. *Frontiers in Human Neuroscience*. http://dx.doi.org/10.3389/fnhum.2014.0035.

Appourchaux, K. (2014). *Un nouveau libre arbitre*. Paris: CNRS.

Bayne, T., & Pacherie, E. (2007). Narrators and comparators: The architecture of agentive self-awareness. *Synthese, 159*(3), 475–491.

Benassi, V. A., Singer, B., & Reynolds, C. B. (1980). Occult belief: Seeing is believing. *Journal for the Scientific Study of Religion, 19*(4), 337–349. http://dx.doi.org/10.2307/1386128.

Blakemore, S. J., Oakley, D. A., & Frith, C. D. (2003). Delusions of alien control in the normal brain. *Neuropsychologia, 41*(8), 1058–1067. http://dx.doi.org/10.1016/S0028-3932(02)00313-5.

Bourguignon, E. (1976). *Possession*. San Francisco: Chandler & Sharp.

Burger, J. M. (1981). Locus of control, motivation, and expectancy: Predicting hypnotic susceptibility from personality variables. *Journal of Research in Personality, 15*(4), 523–537. http://dx.doi.org/10.1016/0092-6566(81)90048-9.

Chambon, V., Sidarus, N., & Haggard, P. (2014). From action intentions to action effects: How does the sense of agency come about? *Frontiers in Human Neuroscience, 8*(320), 1–9. http://dx.doi.org/10.3389/fnhum.2014.00320.

Connors, M. H. (2015). Hypnosis and belief: A review of hypnotic delusions. *Consciousness and Cognition, 36*, 27–43.

Corinda (1968). *Thirteen steps to mentalism (third)*. New York: Tannen Magic.

Cumming, G. (2014). The new statistics: Why and how. *Psychological Science, 25*(1), 7–29. http://dx.doi.org/10.1177/0956797613504966.

Danek, A. H., Fraps, T., von Müller, A., Grothe, B., & Ollinger, M. (2013). Working wonders? Investigating insight with magic tricks. *Cognition, 130*(2), 174–185. http://dx.doi.org/10.1016/j.cognition.2013.11.003.

Duttweiler, P. C. (1984). The internal control index: A newly developed measure of locus of control. *Educational and Psychological Measurement, 44*(2), 209–221. http://dx.doi.org/10.1177/0013164484442004.

Frith, C. D. (2012). Explaining delusions of control: The comparator model 20 years on. *Consciousness and Cognition, 21*(1), 52–54. http://dx.doi.org/10.1016/j.concog.2011.06.010.

Gallagher, S. (2007). The natural philosophy of agency. *Philosophy Compass, 2*(2), 347–357. http://dx.doi.org/10.1119/1.1969491.

Gauchou, H. L., Rensink, R. A., & Fels, S. (2012). Expression of nonconscious knowledge via ideomotor actions. *Consciousness and Cognition, 21*(2), 976–982.

Hall, L., Johansson, P., & Strandberg, T. (2012). Lifting the veil of morality: Choice blindness and attitude reversals on a self-transforming survey. *PloS One, 7*(9), e45457. http://dx.doi.org/10.1371/journal.pone.0045457.

Helton, W. S., & Näswall, K. (2014). Short stress state questionnaire. *European Journal of Psychological Assessment, 1*, 1–11. http://dx.doi.org/10.1027/1015-5759/a000200.

Hothorn, T., Hornik, K., van de Wiel, M., & Zeileis, A. (2008). Implementing a class of permutation tests: The coin package. *Journal of Statistical Software, 28*(8), 1–23.

Humpston, C. S., & Broome, M. R. (2015). The spectra of soundless voices and audible thoughts: Towards an integrative model of auditory verbal hallucinations and thought insertion. *Review of Philosophy and Psychology*, 1–19. http://dx.doi.org/10.1007/s13164-015-0232-9.

Joffe, H. (2012). Thematic analysis. In *Qualitative research methods in mental health and psychotherapy: A guide for students and practitioners* (pp. 147–160). John Wiley & Sons.

Johansson, P., Hall, L., Sikström, S., & Olsson, A. (2005). Failure to detect mismatches between intention and outcome in a simple decision task. *Science, 310*(5745), 116–119.

Kirby, K. N., & Gerlanc, D. (2013). BootES: An R package for bootstrap confidence intervals on effect sizes. *Behavior Research Methods, 45*(4), 905–927. http://dx.doi.org/10.3758/s13428-013-0330-5.

Klock, Voss, Weichenberger, Kathmann, & Kühn (in preparation). Who is thinking? Neural correlates of an altered sense of authorship of thoughts.

Kubovy, M. (1977). Response availability and the apparent spontaneity of numerical choices. *Journal of Experimental Psychology: Human Perception and Performance, 3*(2), 359–364. http://dx.doi.org/10.1037/0096-1523.3.2.359.

Kubovy, M., & Psotka, J. (1976). The predominance of seven and the apparent spontaneity of numerical choices. *Journal of Experimental Psychology: Human Perception and Performance, 2*(2), 291–294. http://dx.doi.org/10.1037/0096-1523.2.2.291.

Lamont, P., & Wiseman, R. (2005). *Magic in theory: An introduction to the theoretical and psychological elements of conjuring*. Bristol: University of Hertfordshire Press.

Lutz, A., & Thompson, E. (2003). Neurophenomenology: Integrating subjective experience and brain dynamics in the neuroscience of consciousness. *Journal of Consciousness Studies, 10*(9–10), 31–52.

Masters, R. E. L., & Houston, J. (1966). *The varieties of psychedelic experience*. Dell.

Mavromatis, A. (1987). *Hypnagogia: the unique state of consciousness between wakefulness and sleep*. London: Routledge & Kegan Paul.

McCabe, D. P., & Castel, A. D. (2008). Seeing is believing: The effect of brain images on judgments of scientific reasoning. *Cognition, 107*(1), 343–352.

Mills, J. (1976). A procedure for explaining experiments involving deception. *Personality and Social Psychology Bulletin, 2*(1), 3–13.

Mullins, S., & Spence, S. A. (2014). Re-examining thought insertion: Semi-structured literature review and conceptual analysis. *British Journal of Psychiatry, 182*, 293–298. http://dx.doi.org/10.1192/bjp.02.322.

Nisbett, R. E., & Wilson, T. D. (1977). Telling more than we can know: Verbal reports on mental processes. *Psychological Review, 84*(3), 231–259. http://dx.doi.org/10.1037/0033-295X.84.3.231.

Olson, J. A., Amlani, A. A., Raz, A., & Rensink, R. A. (2015). Influencing choice without awareness. *Consciousness and Cognition, 37*, 225–236. http://dx.doi.org/10.1016/j.concog.2015.01.004.

Olson, J. A., Amlani, A. A., & Rensink, R. A. (2012). Perceptual and cognitive characteristics of common playing cards. *Perception, 41*(3), 268–286. http://dx.doi.org/10.1068/p7175.

Open Science Collaboration (2015). Estimating the reproducibility of psychological science. *Science, 349*(6251), aac4716. http://dx.doi.org/10.1126/science.aac4716.

Penfield, W., & Roberts, L. (1976). *Speech and brain-mechanisms*. New York: Atheneum.

Peterson, R. (1994). A meta-analysis of Cronbach's coefficient alpha. *Journal of Consumer Research, 21*(2), 381–391.

Petitmengin, C., Remillieux, A., Cahour, B., & Carter-Thomas, S. (2013). A gap in Nisbett and Wilson's findings? A first-person access to our cognitive processes. *Consciousness and Cognition, 22*, 654–669. http://dx.doi.org/10.1016/j.concog.2013.02.004.

Polito, V., Barnier, A. J., & Woody, E. Z. (2013). Developing the Sense of Agency Rating Scale (SOARS): An empirical measure of agency disruption in hypnosis. *Consciousness and Cognition, 22*(3), 684–696. http://dx.doi.org/10.1016/j.concog.2013.04.003.

Polito, V., Langdon, R., & Barnier, A. J. (2015). Sense of agency across contexts: Insights from schizophrenia and hypnosis. *Psychology of Consciousness: Theory, Research, and Practice, 2*(3), 301–314. http://dx.doi.org/10.1037/cns0000053.

Proust, J. (2009). Is there a sense of agency for thought? In L. O'Brien & M. Soteriou (Eds.), *Mental actions*. Oxford University Press.

R Core Team (2015). *R: A language and environment for statistical computing*.

Rensink, R. A., & Kuhn, G. (2014). A framework for using magic to study the mind. *Frontiers in Psychology, 5*(1508). http://dx.doi.org/10.3389/fpsyg.2014.01508.

Rose, D., Buckwalter, W., & Nichols, S. (2015). Neuroscientific prediction and the intrusion of intuitive metaphysics. *Cognitive Science*, 1–21. http://dx.doi.org/10.1111/cogs.12310.

Rotter, J. B. (1966). Generalized expectancies for internal versus external control of reinforcement. *Psychological Monographs: General and Applied, 80*(1), 1–28.

Simmons, J. P., Nelson, L. D., & Simonsohn, U. (2011). False-positive psychology: Undisclosed flexibility in data collection and analysis allows presenting anything as significant. *Psychological Science, 22*(11), 1359–1366. http://dx.doi.org/10.1177/0956797611417632.

Subbotsky, E. (2004). Magical thinking in judgments of causation: Can anomalous phenomena affect ontological causal beliefs in children and adults? *British Journal of Developmental Psychology, 22*, 123–152.

Swiney, L., & Sousa, P. (2013). When our thoughts are not our own: Investigating agency misattributions using the Mind-to-Mind paradigm. *Consciousness and Cognition, 22*(2), 589–602. http://dx.doi.org/10.1016/j.concog.2013.03.007.

Synofzik, M., Thier, P., & Lindner, A. (2006). Internalizing agency of self-action: Perception of one's own hand movements depends on an adaptable prediction about the sensory action outcome. *Journal of Neurophysiology, 96*, 1592–1601. http://dx.doi.org/10.1152/jn.00104.2006.

Synofzik, M., Vosgerau, G., & Newen, A. (2008). Beyond the comparator model: A multifactorial two-step account of agency. *Consciousness and Cognition, 17*(1), 219–239. http://dx.doi.org/10.1016/j.concog.2007.03.010.

Tausk, V. (1969). On the origin of the "influencing apparatus" in schizophrenia (1919). *Psyche, 23*(5), 354–384.

Teller (2012). *Teller reveals his secrets*. Smithsonian.

Thaler, R. H., & Sunstein, C. R. (2008). *Nudge: Improving decisions about health, wealth, and happiness*. Yale University Press.

Vermersch, P. (1994). *L'entretien d'explicitation*.Paris: ESF.

Vohs, K. D., & Schooler, J. W. (2008). The value of believing in free will: Encouraging a belief in determinism increases cheating. *Psychological Science, 19*, 49–54.

Vosgerau, G., & Voss, M. (2013). Authorship and control over thoughts. *Mind & Language, 29*(5), 534–565. http://dx.doi.org/10.1111/mila.12065.

Walsh, E., Oakley, D. A., Halligan, P. W., Mehta, M. A., & Deeley, Q. (2015). The functional anatomy and connectivity of thought insertion and alien control of movement. *Cortex, 64*, 380–393. http://dx.doi.org/10.1016/j.cortex.2014.09.012.

Wegner, D. M. (1994). Ironic processes of mental control. *Psychological Review, 101*(1), 34–52. http://dx.doi.org/10.1037/0033-295X.101.1.34.

Wegner, D. M. (2003). *The illusion of conscious will*. MIT Press.

Wegner, D. M., & Wheatley, T. (1999). Apparent mental causation. *American Psychologist, 54*(7), 480–492.

Wickham, H. (2009). *Ggplot2: Elegant graphics for data analysis*. Springer.

Wilson, K., & French, C. C. (2014). Magic and memory: Using conjuring to explore the effects of suggestion, social influence and paranormal belief on eyewitness testimony for an ostensibly paranormal event. *Frontiers in Psychology, 5*(1289). http://dx.doi.org/10.3389/fpsyg.2014.01289.

Woody, E. Z., & Szechtman, H. (2011). Using hypnosis to develop and test models of psychopathology. *The Journal of Mind-Body Regulaton, 1*(1), 4–16.