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Mirrored-self misidentification in the hypnosis laboratory: Recreating the delusion from its component factors

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Introduction. Mirrored-self misidentification is the delusional belief that one's reflection in the mirror is a stranger. According to Langdon and Coltheart's (2000) "two-factor" theory of monothematic delusions, the delusion can arise from deficits in face processing (Factor 1) and belief evaluation (Factor 2). This study gave participants separate hypnotic suggestions for these two factors to create a hypnotic analogue of the delusion.
Method. Forty-six high hypnotisable participants received a hypnotic suggestion for either Factor 1 alone or for Factors 1 and 2, either with hypnosis (hypnosis condition) or without (wake condition). Participants were asked to look into a mirror and to describe what they saw. Participants who reported seeing a stranger in the mirror also received a series of challenges.
Results. Overall, 70% of participants in the hypnosis condition passed the delusion; only 22% of participants in the wake condition passed. Importantly, in hypnosis, the Factor 1 alone suggestion was just as effective in creating the delusion as the combined Factor 1 and Factor 2 suggestion.
Conclusion. These results suggest that hypnotic suggestion can recreate the mirrored-self misidentification delusion from its component factors. Notably, the hypnotic context, itself known to disrupt belief evaluation, can act as Factor 2.

Keywords: Delusion; Hypnosis; Instrumental hypnosis; Mirror sign; Mirrored-self misidentification.

INTRODUCTION

Delusions of misidentification involve mistaken beliefs about the identity of oneself, other people, places, and objects. One such delusion is mirrored-self misidentification, the belief that one's reflection in the mirror is a stranger (Breen, Caine, & Coltheart, 2001). This delusion usually occurs in the presence of advanced global dementia (Bologna & Camp, 1997; Foley & Breslau, 1982; Förstl et al., 1994; Mendez, Martin, Smyth, & Whitehouse, 1992). In epidemiological studies, it has been found that between 2% and 10% of patients suffering from Alzheimer's disease misidentify their own reflection in the mirror (Burns, Jacoby, & Levy, 1990; Deutsch, Bylsma, Rovner, Steele, & Folstein, 1991; Förstl, Burns, Jacoby, & Levy, 1991; Hyodo et al., 2005; Mendez et al., 1992; Rubin, Drevets, & Burke, 1988). Cases of mirrored-self misidentification have also been reported in the context of schizophrenia (Gluckman, 1968) and right frontal ischemic stroke (Villarejo et al., 2011).

Mirrored-self misidentification differs from other misidentification delusions in that it is limited to mirrors. Unlike the delusion of subjective doubles (Christodoulou, 1978), the belief that one has a physical duplicate in the world, patients with mirrored-self misidentification believe that the person they see is a stranger rather than a double. Patients, nevertheless, vary in how they interact with this ''stranger''. Some patients are indifferent (e.g., Breen et al., 2001) or treat their reflection as a companion (e.g., Phillips, Howard, & David, 1996). Other patients are suspicious or paranoid (e.g., Cummings, 1985; Mendez, 1992). Many patients cover up all mirrors to avoid seeing the stranger, or even throw objects at their reflection (Gluckman, 1968). The delusion can occur despite intact semantic knowledge of mirrors (e.g., the ability to describe the properties and function of mirrors; Breen et al., 2001), and some patients continue to accurately recognise other people's reflections in the mirror (Breen et al., 2001; Feinberg & Shapiro, 1989; Mendez, 1992; Spangenberg, Wagner, & Bachman, 1998).

Langdon and Coltheart's (2000) two-factor theory

Mirrored-self misidentification can occur without any other unusual beliefs and is an example of a monothematic delusion, a delusion confined to a single topic. An influential theory of monothematic delusions is the two-factor account proposed by Langdon and Coltheart (2000; see also Coltheart, 2007; Coltheart, Langdon, & McKay, 2011; Davies, Coltheart, Langdon, & Breen, 2001; McKay, Langdon, & Coltheart, 2005). According to this theory, there are two factors that contribute towards the development and maintenance of a monothematic delusion. The first

factor (Factor 1) is responsible for generating the specific content of a delusion and typically involves a neuropsychological anomaly affecting perceptual and/or emotional processing. In the case of mirrored-self misidentification, this can be either a deficit in face processing (and hence a difficulty recognising one's own face in the mirror) or mirror agnosia (an inability to use mirror knowledge when interacting with mirrors). Both can lead a patient to the hypothesis that there is a stranger in the mirror. Evidence for this comes from Breen et al. (2001), who identified two patients with the delusion, each with different Factor 1 deficits: Patient FE had a deficit in face processing, while Patient TH had mirror agnosia, yet both saw a stranger in the mirror.

Earlier one-factor accounts of delusions, such as Maher's (1974, 1988) theory, argued that such neuropsychological anomalies were sufficient to generate a delusion. Research has shown, however, that many patients with these deficits do not develop a delusion (e.g., see Ellis & Florence, 1990, for a description of nondelusional patients with deficits in face processing, and Connors & Coltheart, 2011, for a description of nondelusional patients with mirror agnosia). To account for these nondelusional patients, in both mirrored-self misidentification and other delusions, Langdon and Coltheart (2000) proposed a second factor (Factor 2). The second factor is responsible for the failure to reject delusional beliefs and involves a deficit in belief evaluation (Ellis & Young, 1996, also proposed a two-factor account, though they suggested that the second factor was an impairment of either an attributional mechanism or a decision-making system). In a similar way, David and Howard (1994) had earlier proposed that a deficit in belief evaluation could explain delusional memory and suggested that belief evaluation could operate on memories by evaluating them in terms of their consistency with stored general knowledge or in terms of their perceptual qualities and narrative details.

In mirrored-self misidentification, a deficit in belief evaluation leads patients to accept as firm belief their hypothesis that there is a stranger in the mirror. This second factor may be either conscious or unconscious (Turner & Coltheart, 2010). According to Turner and Coltheart (2010), ordinary belief evaluation involves two separate systems: An unconscious tagging system marks unusual ideas for further checking and generates a sense of doubt, after which a conscious checking system examines the ideas tagged by the unconscious system. In delusional patients, one or both of these systems fail, resulting in a feeling of conviction and a failure to consciously check the delusional belief. Thus, patients with both Factor 1 (either a deficit in face processing or mirror agnosia) and Factor 2 (a deficit in belief evaluation) will develop the delusion.

Using hypnosis to recreate delusions

Delusions are often difficult to study because of comorbidity with other clinical symptoms and intellectual impairments, and the reluctance of patients to participate in experimental studies. Mirrored-self misidentification delusion is particularly difficult to study because of the extensive cognitive and neurological deterioration associated with conditions in which it is seen (e.g., Alzheimer's disease). The instrumental use of hypnosis provides an alternative and novel means of studying this delusion. Hypnosis can temporarily alter people's perceptual and cognitive experiences (Kihlstrom, 1985, 2008; Nash & Barnier, 2008), which makes it ideal for modelling clinical symptoms in otherwise healthy participants (Kihlstrom, 1979). Such an approach creates what Oakley and Halligan (2009) termed "virtual patients" (p. 266), temporary analogues of clinical conditions that researchers can use to explore hypothesised contributory factors. The effects of different factors can be determined by manipulating them experimentally in the context of the hypnotic model. For this reason, hypnosis has been used successfully to model many other psychopathologies (for reviews, see Barnier & Oakley, 2009; Oakley & Halligan, 2009). These include, for example, conversion hysteria (Halligan, Athwal, Oakley, & Frackowiak, 2000), auditory hallucinations (Szechtman, Woody, Bowers, & Nahmias, 1998), functional amnesia (Barnier, 2002; Barnier, McConkey, & Wright, 2004), functional blindness (Bryant & McConkey, 1989), and paranoia (Zimbardo, Andersen, & Kabat, 1981).

Hypnosis is particularly suited to modelling delusions for two main reasons. First, delusions and hypnosis share many features; both are characterised by distorted perceptions or beliefs about reality and both involve alterations in cognitive processing (e.g., Kihlstrom & Hoyt, 1988; Sutcliffe, 1961). These shared features have, for example, been illustrated in previous work using hypnotic suggestion to model delusions of sex-change (Noble & McConkey, 1995) and identity distortion (Cox & Barnier, 2009). Second, the two-factor theory of delusions is a general cognitive model (Coltheart, 2007). According to this view, specific disruptions to the normal cognitive processes of belief generation and belief evaluation should have predictable consequences, regardless of the particular aetiology of these disruptions. Hypnotic suggestion is a technique that can disrupt normal cognitive processes, mimicking the role that neuropsychological impairments might play in clinical cases but in a way that is temporary and completely reversible (Oakley & Halligan, 2009; see also Cox & Barnier, 2010). Indeed, participants leave the hypnosis laboratory just as they came in—with no distress or consequences—and often return for more experiments.

Given this suitability, Barnier et al. (2008) used hypnosis to recreate the mirrored-self misidentification delusion. In this experiment, a hypnotist gave

each of the 12 high hypnotisable participants a hypnotic induction and one of three versions of a hypnotic suggestion to experience the delusion. These suggestions were: (1) to see a stranger in the mirror, (2) to see a window, or (3) to see a window with a view of a stranger on the other side. Following the suggestion, the hypnotist asked participants to look into a mirror and to describe what they saw. In response, many participants reported seeing a stranger in the mirror and described the person in the mirror as having different physical characteristics to themselves. The hypnotist challenged this delusion by asking participants to first describe what a close friend or family member would say about what they could see, and then to touch their nose while looking in the mirror. All the participants who experienced the delusion maintained their belief throughout these challenges. Overall, then, these hypnotised participants reported experiences and behaved in ways that were strikingly similar to clinical patients (see Bortolotti, Cox, & Barnier, 2011, for a discussion).

Barnier, Cox, Connors, Langdon, and Coltheart (2011) replicated this study, focusing on the most effective suggestion from the previous study— the suggestion to see a stranger in the mirror—with a larger sample of 38 high hypnotisable participants and a more extensive series of challenges. In this replication, we also examined how delusional beliefs might begin as explanations for unusual experiences. In addition to the suggestion to see a stranger in the mirror, we gave half the participants a hypnotic suggestion that they would easily generate reasons to explain seeing a stranger in the mirror. For participants who reported seeing a stranger, we used three types of challenges to determine the resilience of the delusion. In the appearance challenges, the hypnotist asked participants how a close friend or family member would be able to tell them apart from the person in the mirror. Next, in a series of visual challenges, the hypnotist stood next to the participant so that both of their reflections were visible in the mirror and asked participants to explain what they could see. Finally, in two behavioural challenges, the hypnotist asked participants to touch their nose and then to touch a tennis ball held over their shoulder while they looked in the mirror. We found that 68% of participants experienced the delusion. Participants given the suggestion to provide reasons for their experience offered more explanations for seeing a stranger in the mirror than those who did not receive the suggestion. These reasons included, for example, that the mirror was really a window to another room or that some type of trick mirror was being used. However, the suggestion to provide reasons did not affect whether participants reported seeing a stranger or not. The delusion was also resistant to challenge: Just over half the participants who experienced the delusion maintained the delusion through all the challenges. The visual challenge, where the hypnotist stood next to the participant as they looked in the mirror, proved to be especially successful in breaching the delusion.

Current study

In the two previous studies, we gave participants a hypnotic suggestion for the full delusional experience of seeing a stranger in the mirror. However, given that Langdon and Coltheart's (2000) theory is a general cognitive model, we should be able to recreate the delusion from its separable Factor 1 and Factor 2 components. In this study, we focused on a face-processing deficit as the Factor 1 responsible for the content of the mirrored-self misidentification delusion. The specific Factor 1 suggestion we used to model this process was: "You will see a face in the mirror that you will not be able to identify." From this, participants would need to generate the hypothesis that there was a stranger in the mirror and uncritically accept this hypothesis as true in order to experience the delusion. In this study, we also explored different ways to model Factor 2—the deficit in belief evaluation thought to be common to most, if not all, delusions—using hypnosis. Since a hypnotic suggestion may be able to influence the conscious checking system proposed by Turner and Coltheart (2010) and allow an unusual hypothesis to be temporarily accepted as belief, we used a specific suggestion—"you will search for explanations . . . Any explanation you come up with will seem plausible"—to mimic Factor 2 and disrupt this system. Half the participants received the Factor 1 suggestion without this Factor 2 addition (the Factor 1 alone suggestion) and half received the Factor 1 suggestion with this Factor 2 addition (the combined Factor 1 and Factor 2 suggestion).

Hypnosis by itself, however, is known to disrupt critical evaluation and reality monitoring; people tend to accept ideas during hypnosis that they would normally reject in an ordinary, everyday state of consciousness (Bryant & Mallard, 2005; Shor, 1959). Thus, it is possible that the hypnotic state itself might interfere with processes of belief evaluation—whether by disrupting the conscious checking system proposed by Turner and Coltheart (2010) or otherwise—and act as Factor 2. To investigate this, we gave half the participants the suggestions with hypnosis, and we gave the other half the suggestions without hypnosis (in a wake control). We tested the resulting delusion by asking participants to look into a mirror and to respond to what they saw, and we challenged the resilience of the delusion with a series of graded challenges. Finally, we conducted a postexperimental inquiry to index participants' subjective experiences of their temporary mirrored-self mis-identification delusion.

We predicted that participants given the suggestions with hypnosis would be more likely to experience the delusion than those given the suggestions without hypnosis. We expected that participants who experienced the hypnotic mirrored-self misidentification would show features similar to the clinical delusion and that they might maintain this belief despite the

challenges. We were particularly interested in the impact of the specific Factor 2 suggestion versus hypnosis alone. We expected that during hypnosis the combined Factor 1 and Factor 2 suggestion, which was based closely on Langdon and Coltheart's (2000) theory and Breen et al.'s (2001) conceptualisation of mirrored-self misidentification, should lead to a delusional experience. However, if the hypnosis state is sufficient to impair belief evaluation, the Factor 1 alone suggestion with hypnosis also should lead to a delusional experience. This might contrast with the wake condition, where there should be less chance of either altering participants' perceptual experiences (as Factor 1) or of disrupting their belief evaluation (as Factor 2).

METHOD

Design and participants

Forty-six high hypnotisable participants (28 female and 18 male) of mean age 20.28 ($SD = 4.01$) years were tested in a 2 (condition: hypnosis vs. wake) $\times$ 2 (suggestion: Factor 1 alone vs. combined Factor 1 and Factor 2) between-subjects design. Participants were undergraduate psychology students at the University of New South Wales, who received either payment ($25 for 2 hours) or credit towards their course for their involvement. Participants were selected carefully from an original pool of 573 on the basis of their high scores on a 10-item modified version of the Harvard Group Scale of Hypnotic Susceptibility, Form A (HGSHS:A; Shor & Orne, 1962) and a 10-item tailored version of the Stanford Hypnotic Susceptibility Scale, Form C (SHSS:C; Weitzenhoffer & Hilgard, 1962).[1] All participants scored in the range 7–10 on the HGSHS:A ($M = 7.57$, $SD = 0.69$) and 7–10 on the SHSS:C ($M = 8.14$, $SD = 1.02$). On the HGSHS:A, 84 (14.7%) of the 573 participants scored between 7 and 10. Of these, 76 returned for the SHSS:C and 58 (76.3%) scored within the range 7–10. These numbers are consistent with established norms of hypnotisability (McConkey & Barnier, 2004). Participants were asked not to participate in the experiment if they had any chronic, ongoing psychological condition, problems with substance abuse, or

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[1] The 10-item modified HGSHS:A included: head falling, eye closure, hand lowering, finger lock, moving hands together, communication inhibition, experiencing of fly, eye catalepsy, posthypnotic suggestion, and posthypnotic amnesia; arm rigidity and arm immobilisation items were removed to ensure that the procedure could be conducted within the time limits of a 1 hour class. The 10-item tailored SHSS:C included: hand lowering, moving hands apart, mosquito hallucination, taste hallucination, arm rigidity, dream, age regression, arm immobilisation, negative visual hallucination, and posthypnotic amnesia; anosmia and auditory hallucination items were removed to ensure that the procedure could be conducted within the time limits of a 1 hour individual session.

if they had ever suffered a serious head injury or neurological illness. Research was approved by appropriate human research ethics committees at the University of New South Wales.

Apparatus

Both the experimental session and the postexperimental inquiry were recorded using a video camera and a DVD recorder. The video recording of the experimental session was shown to participants during the postexperimental inquiry using a DVD player and a colour monitor. The video recordings were later transcribed for analysis. During the experiment, participants were asked to look at a square mirror (approx. 28.5 cm × 28.5 cm framed with a 2.5 cm wooden border), which was mounted on a wall next to their reclining chair. The mirror was positioned so that participants could look directly into it by turning their head to the right and leaning slightly forward. Before the suggestion and after the cancellation, the mirror was covered with a white screen, which was removed during the suggestion. A tennis ball was used during the challenge procedures. Participants in the wake condition, which is described later, were asked to complete two puzzle tasks in place of the induction used in the hypnosis condition. The first puzzle was the symbol-search task from the Wechsler Adult Intelligence Scale (Wechsler, 1997). The second puzzle required participants to divide an irregular geometric L-shape, printed on a page of A4 paper, into four equal areas (see Nogrady, McConkey, & Perry, 1985). Participants were given a clipboard, ruler, pencil, and eraser to complete this task.

Procedure

An experimenter tested each participant individually in a 2 hour session. This session consisted of an experimental session and a postexperimental inquiry.

Experimental session.   Before the experiment, the experimenter briefly explained the study and obtained the participants' informed consent.

Hypnosis and wake conditions.   Participants were randomly assigned to either a hypnosis ($n = 23$) or wake ($n = 23$) condition. In the hypnosis condition, the experimenter administered a standard induction procedure (approximately 10 minutes, based on the SHSS:C induction; Weitzenhoffer & Hilgard, 1962), which instructed participants to close their eyes, relax, and enter a "deep state of hypnosis" as the hypnotist counted from 1 to 20. In the

wake condition, the experimenter explicitly told participants that no hypnosis was involved in the study. No further mention of hypnosis was made in this condition. In the place of an induction, the experimenter gave participants two puzzle tasks to complete in 10 minutes (see Nogrady et al., 1985) and then instructed them to close their eyes.

Suggestions. All participants received three suggestions from the SHSS:C, including hand lowering, moving hands apart, and arm rigidity (Weitzenhoffer & Hilgard, 1962). The experimenter then uncovered the mirror. Participants were randomly assigned to receive either a Factor 1 alone suggestion ($n = 23$) or the combined Factor 1 and Factor 2 suggestion ($n = 23$). Hypnotised participants who received the Factor 1 alone suggestion were told:

> You feel pleasantly and deeply hypnotised as you continue to listen to my voice. In a moment, I am going to ask you to open your eyes, and when you do, I would like you to lean forward and to look to your right. When you look to your right, there will be a mirror there, and you will see a person in it. When you see this person in the mirror, you will not be able to recognise this person. When you open your eyes and turn your head to your right, whilst remaining as deeply relaxed and comfortably hypnotised as you feel now, you will see a face in the mirror that you will not be able to identify, as if you have never seen this face before.

Participants who received the combined Factor 1 and Factor 2 suggestion were given the Factor 1 alone suggestion but were also told:

> You will not know why you are not able to recognise this person in the mirror and you will search for explanations to account for it. Any explanation you come up with will seem plausible. So any thoughts or explanations you come up with to account for your experiences with the person in the mirror will seem plausible.

After either the Factor 1 alone suggestion or the combined Factor 1 and Factor 2 suggestion, the hypnotist checked that participants understood:

> Do you understand? Fine. When you open your eyes and turn your head to your right, you will see a person in the mirror. I would now like you to slowly open your eyes, turn your head to the right, and look into the mirror.

Participants in the wake condition received the same suggestions but without any reference to "hypnosis" or to being "hypnotised".

Test of the suggestion. To test the suggestion, participants were asked:

1. Please tell me what you see in the mirror.
2. How do you explain seeing that person in the mirror?

If participants reported seeing themselves in the mirror, the experimenter said, "That's fine. You see yourself in the mirror" and cancelled the suggestion (described later in this section). If, however, participants reported seeing someone other than themselves in the mirror, the experimenter asked the following questions:

3. I would like you to tell me more about the person you can see in the mirror.
4. Is the person you can see male or female?
5. What do they look like?
6a. Have you ever seen this person before?

[If yes]: 6b. Who is this person?
           6c. What is it about the person that makes you think they are . . .?
           6d. How do you explain being able to see this person in the mirror?

[If no]: 6b. Do they remind you of anybody? Who do they remind you of?
           6c. What is it about the person in the mirror that reminds you of . . .?

7. In what ways does the person you see look like you?
8. In what ways does the person you see look different to you?

Appearance challenges.   The delusion was challenged based on techniques used by Barnier et al. (2011) and the challenges that Breen et al. (2001) gave to their clinical patients. Participants who reported that they saw themselves in the mirror at any point during the challenges were told, "That's fine. You see yourself in the mirror" and taken straight to the cancellation. In the first set of challenges, the appearance challenges, the experimenter asked participants:

1. How is it possible that you and the person you see look so similar?
2. How is your clothing different to the person you see in the mirror?
3. If a close friend or a member of your family came into the room right now and looked at you and looked in the mirror, what would they say about what they could see?
4. How would they be able to tell you apart from the person you see?
5. How would you explain to them what they see?

Behavioural challenges.   In the second set of challenges, the experimenter said:

1a. I would like you now to touch your nose *[wait for the participants to touch their nose]*. What did the person in the mirror do?

1b. Why did they do that?

   The experimenter then held a tennis ball over the participants' shoulder so that the tennis ball was only visible to participants by its reflection in the mirror. The experimenter said:

2a. I would like you now to touch the tennis ball *[wait for the participants to touch the ball]*. What did the person in the mirror do?
2b. Why did they do that?
 3. How do you explain that the person you can see always does exactly what you do?

This challenge also served as a test of mirror knowledge, to see whether participants correctly reached above their shoulder to touch the ball or whether they reached towards the ball's reflection, as in cases of mirror agnosia (Ajuriaguerra, Strejilevitch, & Tissot, 1963; Binkofski, Buccino, Dohle, Seitz, & Freund, 1999; Connors & Coltheart, 2011).

   Visual challenges.   In this final set of challenges, the experimenter moved position so that their reflection in the mirror was also visible to participants. The experimenter asked:

1a. Who else do you see in the mirror now?
1b. *[If participants report seeing the experimenter but not themselves]*. How do you explain that you can see me but not you?

The experimenter then touched participants on the shoulder and asked:

 2. Who did I touch? You or them?

The experimenter then asked participants:

3a. Take a moment to look around the room and tell me how many people are in the room at the moment?
3b. *[If participants say there are two people]* Ok, if there are two people in the room, and two people in the mirror, who must the people in the mirror be?
4a. Where in the room is the person that you see in the mirror?
4b. *[If participants say that they are not in the room]* How do you explain that you can see the stranger in the mirror but they are not in the room?

   Cancellation.   The experimenter then cancelled the suggestion as follows:

> That's fine. Now lean back, close your eyes and relax. You are comfortably relaxed and deeply hypnotised. You will become even more relaxed and hypnotised as you pay close attention to my voice and my words. Everything is returning back to normal. You are able to recognise yourself in the mirror, just as you always have. Just slowly open your eyes, lean forward and look to your right and tell me what you see ... That's right, it is a normal mirror and you can see your reflection in it. Everything is back to normal. Just lean back and close your eyes again. You are becoming more and more relaxed. Comfortably relaxed and deeply hypnotised.

Participants in the wake condition received the same cancellation but without any reference to "hypnosis" or to being "hypnotised".

Deinduction.   In the hypnosis condition, the experimenter gave participants a standard hypnotic deinduction (based on Weitzenhoffer & Hilgard, 1962). In the wake condition, the experimenter asked participants to count aloud from 20 to 1.

Postexperimental inquiry.   The experimenter explained to participants that he/she would play a video recording of the experimental session and stop the video at particular points to ask them about their experiences. This methodology was adapted from the Experiential Analysis Technique (EAT) of Sheehan and McConkey (1982). The experimenter showed participants the video footage of when they first looked into the mirror and asked: (1) "What did you experience when you looked at the mirror?" (2) "On a scale of 1 to 7, to what extent did you believe there was a stranger in the mirror (1 = "not at all", 7 = "completely")?" (3) "On a scale of 1 to 7, how surprising was it for you to look in the mirror (1 = "not at all surprising", 7 = "extremely surprising")?" (4) "On a scale of 1 to 7, how distressing was it to look in the mirror (1 = "not at all distressing", 7 = "extremely distressing")?" If participants passed the suggestion, the experimenter showed them a replay of the challenges they received and asked about their experiences of each challenge. Finally, the experimenter thoroughly debriefed participants and thanked them for their time.

Coding of responses.   After testing all participants, the videotape records of the experimental session were examined independently by the experimenter and a rater who was unaware of the aims of the experiment and the conditions in which participants were tested. The two raters scored whether or not participants passed the suggestion (i.e., experienced the delusion) and, if so, at what point the delusion was breached during the challenges. For both passing the suggestion and response to the challenges, interrater reliability was 100%.

RESULTS

Overview

We report the results in four sections. First, we report participants' initial response to the suggestion, including the number who experienced the delusion for each condition and suggestion. Next, we report qualitative data on participants' experiences of the delusion. Third, we present data from the postexperimental inquiry, including participants' comments and ratings. Finally, we report participants' responses to the challenges.

Response to the suggestion

Participants were scored as passing the suggestion if they identified their reflection in the mirror as someone other than themselves, as per Barnier et al. (2008) and Barnier et al. (2011). Overall, 16 (69.6%) participants in the hypnosis condition passed the suggestion, while only 5 (21.7%) participants in the wake condition passed the suggestion. In the hypnosis condition, 8 out of 11 (72.7%) participants given the Factor 1 alone suggestion and 8 out of 12 (66.7%) participants given the combined Factor 1 and Factor 2 suggestion experienced the delusion. In the wake condition, only 1 out of 12 (8.3%) participants given the Factor 1 alone suggestion and 4 out of 11 (36.4%) participants given the combined Factor 1 and Factor 2 suggestion experienced the delusion.

These findings show that more participants in the hypnosis condition passed the suggestion than in the wake condition. This was confirmed by a three-way logit log linear analysis involving condition (hypnosis vs. wake), suggestion (Factor 1 alone vs. combined Factor 1 and Factor 2) and passing the suggestion (pass vs. fail). This produced a final model that retained only the two-way interaction between condition and passing the suggestion. The likelihood ratio of the model was $\chi^2(4) = 2.967$, $p = .563$, indicating that the model was a good fit to the data. The interaction between condition and passing the suggestion was significant, $\chi^2(1) = 11.069$, $p = .001$. Odds ratios showed that participants in the hypnosis condition were 8.23 times more likely to report seeing a stranger in the mirror than participants in the wake condition (95% CI [2.17, 31.13]), regardless of the suggestion they received. In contrast, there was no difference between the Factor 1 alone suggestion and the combined Factor 1 and Factor 2 suggestion in terms of whether participants passed the suggestion. This was confirmed by the logit log linear analysis, which did not retain the interaction between suggestion and passing the suggestion. Notably, follow-up chi-square analysis for the hypnosis condition found no significant difference in pass rate between the Factor 1

alone suggestion and the combined Factor 1 and Factor 2 suggestion in hypnosis, $\chi^2(1) = 0.100$, $p = .752$. This means that a suggestion in hypnosis was most successful in creating a hypnotic delusion of mirrored-self misidentification. It did not matter if this suggestion was for Factor 1 alone or for Factor 1 and Factor 2 combined.

Qualitative features of the delusion

Participants who reported seeing a stranger when they looked in the mirror were asked about the person in the mirror. Across hypnosis and wake conditions, of the 21 participants who passed the suggestion, 11 (52.4%) said they had never seen the person before, 6 (28.6%) said the person looked familiar but they were unsure who it was, 1 (4.8%) said it was a specific person they knew, and 3 (14.3%) said it was themselves. These last three participants breached the delusion and were not asked any further questions. Of the 18 remaining participants, 6 (33.3%) said the person did not remind them of anyone they had seen before, 4 (22.2%) said the person was very familiar but could not identify who it reminded them of, 3 (16.7%) said the person reminded them of someone they knew, and 5 (27.8%) said the person reminded them of themselves.

Many participants experiencing the delusion described the person they saw in the mirror as having different physical characteristics to themselves. Of these 18 remaining participants, 17 (94.4%) identified specific similarities and 12 (66.7%) identified specific differences between themselves and the person in the mirror. Participants asked to describe similarities made comments like, "[w]e both have blue eyes and short brown hair" and "[i]t looks like me but older." Based on these similarities, three participants reported that the person could be a relative of theirs. In the postexperimental inquiry, one participant said, for example, "I was very surprised . . . I saw my brother, I mean what is he doing here? Obviously I was anticipating to see myself when I look in the mirror, but I didn't." Another participant said, "I was thinking it's my sister, when I don't have a sister!" When asked to describe differences, one participant said, for example, "[t]he colour of her hair is different, it's lighter than mine. And the colour of her eyes, they're lighter—they're a hazel colour. Her hair is long, and her face is freckled. Her skin is a lot fairer than mine." Another participant said, "[t]heir face looks different . . . Their eyes are a little bit closer together and I think I have more pimples." One male participant identified the person as being female, and two participants described the person as being much older than themselves.

Participants who reported seeing a stranger were asked to explain this. Very few participants were able to provide an explanation. Of the 21 participants who initially reported seeing a stranger, 17 (81.0%) said that

they were not able to provide an explanation. They made comments like, "I don't know" and "I can't explain it." The four (19.0%) participants who did provide an explanation suggested that it might be a stranger impersonating them in the next room or that some sort of mirror trick was involved. One of these participants said, for example, "[t]hey are in the room next door", while another said, "[i]t's a projection from the computer." In the postexperimental inquiry, one of these participants said, "I couldn't make sense of it . . . I think the explanation that it was a window into another room seemed the most plausible to me." The participants that offered an explanation, however, were in the minority.

Postexperimental comments and ratings

After the cancellation, all participants reported seeing themselves in the mirror. Participants' comments in the postexperimental inquiry, as they reflected on their experience and commented on the video of the experimental session, confirm the compelling nature of the delusion for some participants. One participant, for example, said, "[f]or some reason it wasn't adding up that it was my face . . . When I was looking at it I knew that I should see me, but it really didn't look like me. It was weird, sort of a bit unsettling . . . it felt really unfamiliar." Another participant said, "I thought that there was some odd fellow looking at me and doing exactly as I was doing . . . I thought that was a bit strange." A third participant said, "[i]t was so weird. I knew that I should be in the mirror, but it did not look like me." Many participants reported feeling surprised or confused by the experience. They made comments such as, "I was shocked, I didn't know what was going on", "[i]t was really weird. It just didn't feel like it was me", and "I was trying to figure out who it was. I was thinking, 'why is this person so familiar?'"

These comments are reinforced by participants' ratings. During the postexperimental inquiry, 25 participants (15 in the hypnosis condition, 10 in the wake condition) rated the extent to which they believed there was a stranger in the mirror (1 = "not at all", 7 = "completely"). These 25 participants also rated how distressing and surprising it was to look in the mirror (1 = "not at all", 7 = "extremely"). Ratings from the remaining 21 participants were not collected. Separate 2 (condition: hypnosis vs. wake) × 2 (suggestion: Factor 1 vs. combined Factor 1 and Factor 2) ANOVAs were conducted. Participants in the hypnosis condition ($M = 4.60$, $SD = 1.50$) rated their belief that they were looking at a stranger more strongly than participants in the wake condition ($M = 2.90$, $SD = 1.73$), $F(1, 21) = 6.652$, $p = .017$. There was no difference in ratings of belief between suggestions, $F(1, 21) = .202$, $p = .658$, and no interaction, $F(1, 21) = .465$, $p = .503$. There

was no difference between conditions or suggestions in ratings of surprise and distress (all Fs > 1.175, all ps <.291). The mean rating of surprise was 4.90 ($SD = 1.95$) and the mean rating of distress was 3.70 ($SD = 2.18$).

Interestingly, during the postexperimental inquiry, a number of participants who failed the suggestion according to the formal criterion reported some effects of the suggestion. Of the 25 participants who failed the suggestion, 11 (44.0%; 3 in the hypnosis condition, 8 in the wake condition) reported a delay in recognising themselves when they first looked in the mirror.

Response to challenges

Of the 21 participants who initially passed the suggestion, three participants failed to maintain the suggested delusion during the initial questioning when asked to describe the person they saw; they indicated that they saw themselves, so they did not receive the challenges. This left 18 participants who received the first challenge. The number of participants who maintained the delusion after each challenge is shown in Table 1. Chi square analysis

TABLE 1
The number of participants maintaining the delusion after each challenge

	Factor 1 alone suggestion		Combined Factor 1 + Factor 2 suggestion		
	Hypnosis	Wake	Hypnosis	Wake	Total
Participants receiving the challenges	7	1	6	4	18
Appearance challenges					
1. Explain similarity to stranger	7	0	6	4	17
2. Compare clothes to stranger	7	0	6	4	17
3. Describe what a friend would say	7	0	6	4	17
4. Describe how a friend could distinguish	7	0	6	4	17
5. Explain to a friend what they can see	7	0	6	4	17
Behavioural challenges					
1. Touch their nose and explain	6	0	6	4	16
2. Touch a tennis ball and explain	6	0	6	2	14
3. Explain why the stranger copied them	6	0	5	2	13
Visual challenges					
1. Hypnotist stands so visible in the mirror	6	0	5	2	13
2. Hypnotist touches participants' shoulder	6	0	5	2	13
3. Count number of people in mirror and room	5	0	3	2	10
4. Explain why stranger is not in the room	5	0	3	2	10

indicated that there was no difference in response to the challenges according to either the condition participants were in or the suggestion they received.

In response to the appearance challenges, 17 of the 18 participants receiving the challenges maintained the delusion. When asked to explain their similarity to the person in the mirror, participants made comments like, "[w]e might be related", "[i]t's just a coincidence", and "[i]t's just someone that looks like me." When asked how their clothes compared to those of the person in the mirror, one participant who was wearing a scarf, said, "I've got no scarf . . . They're wearing my scarf!" When asked what a close friend or family member would say, one participant said, "I think they'd say it was like my sister but I don't have a sister." Another said, "I don't know. They'd probably say we look pretty similar. We don't look that different." Of the 17 participants who maintained the delusion, 7 (41.2%) participants identified specific physical differences that their family could use to distinguish them from the person in the mirror. One participant said, for example, "[t]heir nose is straighter than mine, I have a bump in my nose. Their hair is neater than mine—my hair is uncontrollably messy." Another participant said, "I don't hold my mouth open like that. My eyes are wider. And my hair is shorter."

In response to the behavioural challenges, 13 of the 17 participants receiving the challenges maintained the delusion. When asked to explain why the person in the mirror touched their nose at the same the participant did, participants made comments like, "[t]hey're copying me" and "I think they're mirroring my actions. They've been doing it the whole time, even when I'm speaking. He's pretty good at it actually." Another participant, when asked to explain why the person in the mirror always did the same things they did, said, "part of the experiment I guess. Maybe just trying to see if I think that's me or not." Of the 16 participants asked to reach for the tennis ball above their shoulder, all 16 correctly reached for the ball rather than for the ball's reflection, and so did not show signs of mirror agnosia. During the postexperimental inquiry, participants who received the behavioural challenges were asked how they felt when the stranger copied everything they were doing. Those who maintained their delusion in response to this challenge made comments such as: "I felt slightly annoyed actually. I thought it was a bit strange. And then I was amazed at how incredibly well he was doing it. It was like 'that's exactly what I'm doing, how the hell is he doing that?'" Another participant said, "[t]hat freaked me out beyond anything. I wanted them to go away, I didn't want them to copy me anymore. It never occurred to me that . . . 'Duh, It's your mirror image.' That never occurred to me at all. I was just thinking why? Why are they doing it? Why are they copying me? But I didn't know why. [I thought] 'Go away.' I was really frustrated and angry."

In response to the visual challenges, 10 of the 13 participants maintained the delusion. Participants made comments like, "[i]t's weird. I don't have an explanation", "[i]t might be a window", and "[t]hey're not in the room ... I can't explain it." A participant who breached the delusion said, "It must be us. But you look the same and I don't. Maybe it's because you told me I wouldn't recognise the person in the mirror." Of the 13 participants who received the visual challenges, 9 (69.2%) said that they saw the experimenter in the mirror and 4 (30.8%) said that it was another person. During the postexperimental inquiry, these participants were asked what they experienced when the experimenter appeared in the mirror next to them. One participant, for example, said, "I saw two people. I recognised you. I knew that it was you, but I still didn't recognise my own face. It was very odd." Another participant said, "[t]hat freaked me out! There were two of you ... I didn't know why you were there [in the mirror], you just were ... I couldn't comprehend what was happening. I thought you were a clone." Another participant said: "I probably felt a little embarrassed about it ... because even when I knew it was me at the end ... I still couldn't express clearly that it was definitely me. I think I felt a little embarrassed by how out of control I was with the whole experience."

DISCUSSION

The current study demonstrates that hypnosis and suggestion can be used to model the mirrored-self misidentification delusion from its proposed Factor 1 and Factor 2 components. This study used a suggestion for impaired face recognition without specifically mentioning a stranger and found that the majority of participants given this suggestion in hypnosis reported seeing a stranger in the mirror. Interestingly, within hypnosis, the Factor 1 alone suggestion was just as successful in generating the delusion as the combined Factor 1 and Factor 2 suggestion. This suggests that hypnosis, which itself is known to disrupt belief evaluation, can act as Factor 2 in this analogue.

The Factor 1 suggestion we used for impaired face processing produced specific characteristics that matched those of delusional patients with this deficit. Despite reporting that they saw a stranger, the participants showed no evidence of disruption in their semantic and procedural understanding of how mirrors work. This was demonstrated, for example, in the challenges when the participants who were asked to reach for a tennis ball that was held over their shoulder correctly reached for the ball rather than its reflection in the mirror, and in verbal reports (one participant, for example, who was surprised at seeing a stranger said, "I'm looking into a mirror so technically I should see someone who looks like me!"). Also, 13 of 18 participants experiencing the delusion accurately identified the experimenter's reflection in

the mirror. These features are consistent with Breen et al.'s (2001) clinical reports, where patient FE with impaired face recognition showed no apparent difficulty with understanding mirrors and was able to identify the experimenter's reflection in the mirror. In contrast, patient TH, with mirror agnosia rather than impaired face processing as Factor 1, reported that all other people's reflections in the mirror, including the experimenter's, were strangers (Breen et al., 2001; Coltheart, 2007).

The experiment also recreated a number of idiosyncratic features of the delusion that are evident in some clinical cases but not others. Many of our participants, for example, believed that the person in the mirror looked different to how they look, which is consistent with a number of clinical cases (e.g., Phillips et al., 1996). Two of our participants reported that the stranger was of a very different age to what they were, in much the same way that one clinical case, an elderly woman, reported seeing a little girl in the mirror (Spangenberg et al., 1998; see also Bologna & Camp, 1995). Several of our participants also reported that the person in the mirror was a relative of theirs, just like a number of clinical cases reported in the literature (Bologna & Camp, 1995; Goldin, 1955; Hemphill, 1948; Villarejo et al., 2011).

In addition, our hypnotic analogue reproduced the wide variety of attitudes and ways of interacting with the mirror image seen in clinical cases. Some of our participants, for instance, remained largely indifferent, like FE and other cases (e.g., Breen et al., 2001), or even amused by the stranger. A few participants seemed suspicious or paranoid about the stranger. Like other clinical cases who reported fearing that the person in the mirror would steal from them or take over their identity (e.g., Cummings, 1985; Gluckman, 1968; Mendez, 1992), one of our participants said that she was afraid that the person in the mirror was going to take over her life. Another participant avoided looking in the mirror altogether, and a third participant openly expressed her dislike for the person in the mirror. Overall, hypnotised participants responding to the suggestion for mirrored-self misidentification showed remarkable similarities to clinical cases. The fact that this analogue captured the idiosyncratic qualities of the delusion suggests that much of the variability, in both the hypnotic and clinical presentations, might be due to premorbid personality characteristics or other preexisting individual differences.

Comparisons to previous research

The suggestion in this study that attempted to recreate the delusion from its components yielded a very similar pass rate to the suggestion used in previous work that specified the fully formed delusional experience of seeing

a stranger in the mirror. In the current study, 70% of participants in the hypnosis condition reported seeing a stranger in the mirror. In Barnier et al. (2008) and Barnier et al. (2011), 67% and 68% of participants passed the suggestion, respectively. The consistency of pass rates across these studies is striking, and indicates that a suggestion for Factor 1 alone can be just as effective as a suggestion for the fully formed delusional experience. This is notable because the Factor 1 suggestion requires participants to generate the delusional hypothesis—that there is a stranger in the mirror—by themselves. The suggestion used in our earlier work, in contrast, directly specified to participants that they would see a stranger. It seems that this additional specification is unnecessary. Future research could directly compare the two types of suggestion to determine which approach best approximates the features of the clinical delusion.

This study also extended previous research by including a wake control. Although the pass rates for this condition were significantly lower than those in the hypnosis condition, five participants in the wake condition still reported seeing a stranger in the mirror. This is consistent with previous research, which indicates that some high hypnotisable participants can experience hypnotic effects even in the absence of a formal hypnotic induction (Laurence, Beaulieu-Prévost, & du Chéné, 2008; McConkey, Szeps, & Barnier, 2001). Interestingly, however, other participants in the wake condition, who failed according to the formal criterion, reported apparent effects of the suggestion. As noted earlier, of the participants in both hypnosis and wake conditions who failed the suggestion, 44% reported a delay in recognising themselves. Most of these participants were in the wake condition. This is interesting because it is consistent with the two-factor approach taken here: The participants who reported a delay in recognising themselves may have initially experienced Factor 1 without Factor 2 in this analogue. When they tested their hypothesis that they were looking at a stranger (and without hypnosis to impair their ability to evaluate beliefs), they correctly rejected this belief and so did not develop the delusion. Future research could examine this possibility further.

Factor 2

The current study sheds light on the nature of Factor 2 in this hypnotic analogue. The Factor 1 alone suggestion was able to generate the delusion in hypnosis but was not very effective outside of hypnosis. This indicates the need for a second factor in this analogue and suggests that the hypnotic state itself can act in this role. This effect of hypnosis is consistent with previous work which has shown that hypnotised participants reinterpret reality in line with the suggestion, avoid and ignore contradictory information, and

process information in a biased way (Burn, Barnier, & McConkey, 2001; McConkey, 1991, 2008; Sheehan, 1991, 1992; Shor, 1959; Sutcliffe, 1961). These changes following a hypnotic induction have been referred to as a shift in generalised reality orientation (Shor, 1959). This shift might also disrupt the conscious checking system that Turner and Coltheart (2010) proposed evaluates hypotheses before they are accepted as beliefs. Overall, our findings are consistent with Langdon and Coltheart's (2000) two-factor approach, which suggests that an anomalous perceptual experience can underpin the generation of bizarre delusional content. In the case of mirrored-self misidentification, the experience of not recognising oneself in the mirror can lead to a hypothesis that it is a stranger. When coupled with a disruption in belief evaluation, whether hypnotic or neuropsychological in origin, a patient may accept this hypothesis as belief.

The combined Factor 1 and Factor 2 suggestion, however, was no more effective in producing the delusion than the Factor 1 alone suggestion: Participants given the combined Factor 1 and Factor 2 suggestion were no more likely to experience or maintain the delusion than those given just the Factor 1 alone suggestion. In the hypnosis condition, it is possible that this was due to a ceiling effect; the suggestion for Factor 1 alone was highly effective. In the wake condition, where fewer participants passed the suggestion, there was a trend—though not statistically significant—for the combined Factor 1 and Factor 2 suggestion to produce a higher pass rate than the Factor 1 alone suggestion. It might be possible that, in the absence of a hypnotic induction, the Factor 2 suggestion helped some participants experience the delusion by providing a strategy to interpret the suggestion. Nevertheless, results indicate that the specific Factor 2 suggestion did not add anything to hypnosis alone in its modelling of Factor 2.

Response to challenges

We found that the delusion was resistant to challenge in many participants. Almost half the participants who reported seeing a stranger in the mirror continued to maintain this belief throughout the challenge procedures. There was no difference in response to the challenges across the two types of suggestions or across hypnosis and wake conditions (though this conclusion is limited by the small number of participants who passed the suggestion in the wake condition). It is important to note that the large number of challenges used in this study is unusual in hypnosis research, and is more like the testing that takes place in a neuropsychological context. The fact that many participants were able to maintain the delusion in the face of such relentless challenges is interesting because it illustrates how compelling a

hypnotic delusion can be (see also Coe & Sluis, 1989; Noble & McConkey, 1995).

With regard to the specific sets of challenges used in this experiment, there seemed to be little difference in their effectiveness. The behavioural and visual challenges, in particular, breached a similar number of participants' delusions. This differs from the finding of Barnier et al. (2011) that the visual challenges were more effective than other challenges. Together, these findings suggest that the impact of the challenges may depend on the order in which they are presented rather than their specific characteristics. As evidence accumulates against the idea that there is a stranger in the mirror, some participants may give up this belief. Given the possible application of these challenges to treatment, future research could systematically vary the order and type of challenges to more clearly determine their effectiveness.

Conclusions and future directions

This study adds to earlier work by again demonstrating that hypnosis can create a nonclinical analogue of delusions. The present study is the first of its kind to show that a delusion can be recreated from its Factor 1 and Factor 2 components in a laboratory setting. This is promising as it suggests that we can hypnotically recreate other delusions from their constituent factors. As Oakley and Halligan (2009) observed, by using hypnosis in this way, researchers can recreate clinical conditions in large numbers of participants, control and vary potential contributory factors, and thus test and refine models of psychopathology. In future, this approach also offers the possibility of new treatment options by exploring techniques to challenge hypnotic versions of clinical delusions.

This research could be extended in a number of ways. First, future studies could examine more closely how well the Factor 1 suggestion produces the Factor 1 impairment seen in clinical cases. Research, for example, could investigate how hypnotised participants perform on formal tests of face processing and examine whether the effects of the suggestion extend to other media (some clinical cases, like FE, continue to be able to recognise themselves in photographs; Breen et al., 2001). Second, future research could use a hypnotic suggestion to recreate mirrored-self misidentification from its alternative Factor 1, mirror agnosia, and compare the effectiveness of this suggestion to produce the delusion with the suggestion for impaired face processing used in the current study. Another study we have conducted has shown that a hypnotic suggestion for mirror agnosia can recreate features of the delusion (Connors, Cox, Barnier, Langdon, & Coltheart, 2011). Third, future research might examine if particular individual differences—such as proneness to delusional ideation or schizotypy—predict which participants

develop the delusion in hypnosis. There is an extensive literature that confirms the ability to experience hypnosis is not related to broad personality characteristics, such as extroversion, neuroticism, and conscientiousness (Kihlstrom, 1985; Laurence et al., 2008). There is some initial, weak evidence to suggest that hypnotisability may be related to characteristics associated with delusions, such as source monitoring failures (Heaps & Nash, 1999) and proneness to delusional ideation (Connors, 2011), but more work is needed. Fourth, future research could examine if our findings can be extended to other types of clinical delusions. Finally, future research could investigate the demand characteristics of this research by using a "real-simulating" paradigm (e.g., Orne, 1959, 1972), where the responses of hypnotised participants are compared to the responses of low hypnotisable participants faking hypnosis, to test the limits of the hypnotic analogue. Such work will strengthen this new and valuable paradigm for investigating delusions, as well as provide further insights into the cognitive processes underlying delusions and belief formation more generally.

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