Procedural memory in dissociative identity disorder: When can inter-identity amnesia be truly established?[☆]

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Abstract

In a serial reaction time task, procedural memory was examined in Dissociative Identity Disorder (DID). Thirty-one DID patients were tested for inter-identity transfer of procedural learning and their memory performance was compared with 25 normal controls and 25 controls instructed to simulate DID. Results of patients seemed to indicate a pattern of inter-identity amnesia. Simulators, however, were able to mimic a pattern of inter-identity amnesia, rendering the results of patients impossible to interpret as either a pattern of amnesia or a pattern of simulation. It is argued that studies not including DID-simulators or simulation-free memory tasks, should not be taken as evidence for (or against) amnesia in DID.
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1. Introduction

Overactive, underactive, obsessive, or avoidant utilizations of memory characterize numerous psychopathologies (Spiegel, Frischholz, & Spira, 1988). A disorder in which a functional failure of memory is considered to be a core phenomenon is Dissociative Identity Disorder (DID), previously referred to as Multiple Personality Disorder (MPD). In the Diagnostic and Statistical Manual of Mental Disorders, 4th ed. (American Psychiatric Association, 1994), DID is characterized by the presence of two or more distinct identities or personality states, who recurrently take control of the person's behavior and who each have their own relatively enduring pattern of perceiving, relating to, and thinking about the environment and self. DID patients very frequently report episodes of inter-identity amnesia, in which an identity claims amnesia for events experienced by other identities (Boon & Draijer, 1993; Coons, Bowman, & Milstein, 1988; Putnam, Guroff, Silberman, Barban, & Post, 1986; Ross et al., 1990; for a review see Gleaves, May, & Cardeña, 2001). However, this does not mean that patients report a dense amnesia between all identities. Different degrees of amnesia may exist between various identities and reported amnesia may either be mutually or one-way, that is, identity A reports awareness of the experiences of identity B, while B reports no knowledge of the experiences of identity A (Ellenberger, 1970; Janet, 1907; Peters, Uyterlinde, Consemulder, & Van der Hart, 1998).

Whereas most clinical DID experts agree that DID is accompanied by a disturbance in episodic memory, they seem to disagree as to whether identities share implicit memory, such as priming and procedural memory (cf. Merckelbach, Devilly, & Rassin, 2001), that is, the expression of information without conscious recollection (Schacter, 1987). Putnam (1997), for example, stated that "fluctuations in the level of basic skills, in habits, and in recall of knowledge are classic forms of memory dysfunction in dissociative patients" (p. 82) and "paradoxically, it seems as if overlearned information and skills are especially susceptible to intermittent failures of memory retrieval" (p. 83). On the other hand, Cardeña (2000) stated "in dissociative amnesia, the individual loses explicit memory for personal experience, while implicit memory for general knowledge, skills, habits, and conditioned responses is unimpaired" (p. 57).

Six experimental studies have examined implicit memory transfer between identities, most of them focusing on inter-identity priming (Dick-Barnes, Nelson, & Aine, 1987; Eich, Macaulay, Loewenstein, & Dihle, 1997a, Eich, Macaulay, Loewenstein, & Dihle, 1997b; Huntjens et al., 2002; Nissen, Ross, Willingham, Mackenzie, & Schacter, 1988; Peters et al., 1998; for a review see Dorahy, 2001). Priming studies have yielded mixed results, which Eich et al. (1997a) and Nissen et al. (1988) ascribed to the influence of what they called identity-specific factors at the time of encoding and retrieval. In terms of encoding, evidence of amnesia in DID was obtained on conceptually driven tasks that make use of semantically rich materials that they argued was interpreted in different ways by different identities. In contrast, evidence of transfer between identities was obtained on data-driven tasks, in which, according to their reasoning, encoding leaves little room for identity-specific interpretation. In terms of retrieval, transfer of information was obtained on tasks allowing for only a single response on each trial and evidence of amnesia was obtained on tasks allowing a wide range of responses. However, in the most recent study on inter-identity priming in DID, which was performed by our group, we found no objective evidence for inter-identity amnesia on a variety of priming tasks including both conceptually driven and perceptually driven tasks, and both tasks with single and multiple responses (Huntjens et al., 2002).

Of the above mentioned, only two studies have included tasks that pertain to the procedural memory system, that is, the memory system that is involved is learning skills and "knowing how" to do things: riding a bicycle, typing words on a keyboard, or solving a jigsaw puzzle (Schacter, 1996).

The first study on procedural memory in DID was performed by Dick-Barnes et al. (1987), who used a pursuit-rotor task designed to assess the transfer of perceptual-motor training. Results indicated a practice effect, which is transfer of procedural knowledge learning across the three identities tested. In this study, however, no information was given about the a priori reported amnesia between the participating identities, making the results inapt as a case against inter-identity amnesia.

Nissen et al. (1988) performed the second study on procedural memory in DID. Two identities were tested, both reporting amnesia for experiences of the other identity. The authors made use of the serial reaction time (SRT) task introduced by Nissen and Bullemer (1987) that has become a standard task to assess the acquisition and retention of new procedural associations. We will discuss this task in more detail because in the present study we also used a SRT task. Participants are asked to respond as quickly as possible to a stimulus (e.g., a light, an asterisk) that is presented at one of four horizontally aligned locations on a computer screen. Four keys are spatially mapped to the four locations, and participants are asked to press the key in response to the stimulus as fast as possible without making errors. Each response triggers the presentation of the next stimulus, which in turn requires a new response, etc. The critical experimental variation lies in the sequence of stimuli. Subjects respond either to a cyclically repeating sequence (resulting also in a cyclically repeating sequence of responses) or to a random sequence, the constraint being that the same position cannot be used on successive trials.

In the Nissen et al. (1988) study, first one identity was given three blocks of trials in a random-sequence condition. Then, the other identity was given four blocks of trials in a 10-trial repeating sequence and a fifth block consisting of a random sequence instead of the repeating sequence. Response time (RT) decreases more when a repeating sequence is presented than when a random sequence is presented, and RT increases when the stimulus presentation switches from a repeating to a random sequence. These sequence-specific RT effects indicate sequential learning. This identity showed some learning of the sequence. Finally, the first identity performed three blocks of the repeating sequence blocks and then one random block. Results indicated this identity's performance was facilitated by the other identity's acquisition of the sequence.

The Nissen et al. (1988) study has some limitations. Similar to the Dick-Barnes et al. (1987) study, only 1 patient was tested. Furthermore, no statistical tests were applied, which makes the interpretation of the data somewhat difficult. The assessment of the degree of the patient's learning was also complicated by the omission of a normal control group. Finally, no measures to prevent or detect simulation were included, which seems important given that the so-called "sociocognitive" model considers DID to be a syndrome of social creation or iatrogenesis in the treatment of suggestible individuals (Allen & Movius, 2000; Lilienfeld et al., 1999; Spanos, 1996).

Procedural memory is relevant to our everyday functioning because it connects traces of previous experiences to direct motor actions. It is therefore important to establish if and to what extent DID patients suffer limitations (viz., amnesia) in their procedural skill learning ability. The purpose of the present study thus was to systematically investigate procedural memory in DID.

Specifically, we designed an experiment to overcome some of the methodological shortcomings of previous studies, by including a relatively large sample of female DID patients ($n = 31$) as well as a normal control group comparable on sex, mean age, and education-level ($n = 25$). Subjects were presented with eight blocks of trials, with the first and the last block containing repetitions of a random sequence and the other blocks containing the same repeating sequence. To diminish the possibility of simulation of inter-identity amnesia by conscious influencing of task performance, we took several measures to discourage explicit memory processing and encourage implicit memory processing. First, following Pascual-Leone, Wasserman, Grafman, and Hallett (1996), we told participants that the location of the stimulus on each successive trial was random and we used a 12-trial instead of a 10-trial sequence to prevent recognition of the repeating sequence of stimuli. For the same reason, we instructed participants to react as accurately, but above all, to react as fast as possible, and we repeated this instruction several times to ensure high-speed performance. Finally, to prevent recognition of the sequence, we used a sequence of stimuli with less statistical structure than the sequence used by Nissen et al. (1988). As statistical structure increases, there are fewer unique runs of trials of a given size, and specific runs are repeated more often. An example of a low structure sequence is BDBCABADAC, in which no run of two or more trials is repeated (Stadler, 1992). Finally, to detect if simulation of inter-identity amnesia indeed was not possible on the task employed, we included a second control group instructed to simulate DID ($n = 25$). The DID simulators were asked to make up an imaginary, "amnesic" identity and to "switch" upon request to this amnesic identity during the experiment.

Controls were expected to show evidence of sequence learning, which would be evident in a decrease in response times in the blocks containing a repeating sequence (blocks 2–7) and an increase in response times when the stimulus presentation switches from a repeating to a random sequence (block 7 vs. 8). Patients as well as simulators were asked to switch to their amnesic identity after the fourth block. In case of inter-identity amnesia, patients were believed not to show evidence of previous exposure to the task, which is learning of the repeating sequence. They were thus expected to show an increase in response times after the switch to their amnesic identity, indicative of "starting all over again." Because of the measures we took to prevent simulation, simulators were not expected to be able to simulate inter-identity amnesia in their imagined identity. Their scores were thus hypothesized to equal the control scores.

2. Method

2.1. Participants

Thirty-one female DID patients participated in the study. These are the same patients who participated in the Huntjens et al. (2002) and Huntjens, Postma, Peters, Woertman, and Van der Hart (2003) papers. Patients were recruited with the help of clinicians in the Netherlands and Belgium. To be eligible for participation, patients had to meet the DSM-IV (1994) criteria and the criteria of the Structured Clinical Interview for DSM-IV Dissociative Disorders (SCID-D), a semi-structured interview used to diagnose the DSM-IV dissociative disorders (Boon & Draijer, 1994; Steinberg, 1993). The mean number of years since diagnosis of DID for patients was 4.42 years (range 3 months–11 years), and DID was always the main reason for patients to be in treatment.

Participants were informed that the aim of the study was to understand more about the memory problems often reported by DID patients. Patients self-selected two identities that would participate in the experiment. Borrowing terms prevalent in DID clinical practice, conditions for participation were described as follows: (1) at least one of the identities is completely amnesic for the events experienced by the other participating identity during the experiment; (2) the two identities are able to perform the tasks without interference from other identities; (3) the two identities are able to perform the tasks without spontaneous switches to other identities; (4) the patient is able to switch on request between the two identities. The selected identities could be either of the female or of the male perceived gender type. The switching process was assisted either by the patients' own clinician or by one of the authors (RH or OvdH). The transition was initiated by asking the patient to let an identity ''come forward'' and take control over the patient's consciousness and behavior. Also, the patient was asked to let the other participating identity ''step back,'' and move out of consciousness.

In addition, 50 female control participants participated. Groups were comparable on age and education (see Table 1). Control participants did not report any relevant memory, visual, or attentional problems, or psychiatric disorders. Control participants were divided into two groups, called the ''controls'' and the ''simulators.'' Simulators were instructed to imitate DID. They were shown a documentary about a DID-patient and were given additional written information about DID. They were subsequently asked to make up an imaginary, amnesic identity and come up with detailed characteristics of this identity. Following Silberman, Putnam, Weingartner, Braun, and Post (1985), they were given a 17-item data sheet for the identity on which they were asked to assign name, age, sex, physical description, personal history, and personality style. Examination of the completed data sheets confirmed that participants had invested considerable effort in inventing an identity. Finally, they were asked to practice during the week preceding the experiment switching to their new identity and taking on its state of mind. Both the controls and the simulators completed the Dissociative Experiences Scale (DES; Carlson & Putnam, 1993) and the Creative Experiences Questionnaire (CEQ; Merckelbach, Muris, Schmidt, Rassin, & Horselenberg, 1998) (see Table 1). The DES is a 28-item self-report questionnaire with scores ranging from 0 to 100. Scores above 20 or, more conservatively, above 30, are thought to be indicative of

Table 1
Participant characteristics for the three groups: DID patients, controls, and simulators

	Age (years)	Education	DES	CEQ
DID patients (*n* = 31)				
M	38.48	5.39	—	—
SD	8.68	1.20	—	—
Controls (*n* = 25)				
M	37.72	5.88	6.31	5.48
SD	11.29	1.13	4.10	3.24
Simulators (*n* = 25)				
M	32.48	5.84	6.54	4.20
SD	10.31	1.14	3.93	2.58

Note. Education is assessed in categories from 1 (low) to 7 (high) (Verhage, 1964); The DES is the Dissociative Experiences Scale with score range from 0 to 100, and the CEQ is the Creative Experiences Questionnaire with score range from 0 to 25.

pathological dissociation. The CEQ is a 25-item self-report questionnaire with scores ranging from 0 to 25. Scores are thought to be indicative of fantasy proneness, that is, the inclination to be immersed in daydreams and fantasies. The controls and the simulators did not differ significantly on DES-scores and CEQ scores. Neither controls nor simulators showed pathological levels of dissociation as measured by the DES. Written informed consent was obtained from all participants prior to participation.

2.2. Stimuli and apparatus

Participants performed a Serial Reaction Time (SRT) task. On each trial, four locations arranged horizontally on a computer monitor were underscored, and a small rectangle appeared above one of them. The stimulus was a yellow character on a black background and 0.5 cm wide × 1 cm high. All four locations were easily discriminable and 5 cm from the bottom of the monitor screen and separated horizontally by 7 cm. Participants responded by pressing the z, x, n, and m keys on the computer keyboard, which was positioned below and in front of the monitor such that the four keys were approximately aligned with the four stimulus locations. The four keys were marked and the z key was the correct key for the leftmost position, the x key for the position second from left, and so on. The stimulus remained on the screen until the participant pressed the correct key, upon which the next stimulus appeared without an inter-stimulus delay. If the subject pressed the incorrect key, the stimulus changed color to gray and the correct key had to be pressed before the next trial was presented. No feedback was given regarding response latency.

Each block consisted of 120 trials, which was followed by a short break of 30 s, after which subjects initiated the next block by pressing a key when they were ready. The blocks consisted either of a random sequence, the only constraint being that the same event could not occur on two successive trials, or of an ordered sequence, in which the location of the stimulus followed a particular 12-trials sequence. Designating the four locations A, B, C, and D from left to right, the sequence was as follows: B-D-B-C-A-B-A-D-A-C-D-C. Each block comprised 10 repetitions of this 12-trial sequence, but the end of one 12-trials sequence and the beginning of the next was not marked in any way. Thus, in the absence of knowledge of the sequence itself, each block would seem to be a continuous series of 120 trials.

2.3. Procedure

The task was presented in 8 blocks of 120 trials each and two practice blocks of 12 trials, one preceding block 1 and one preceding block 5. Participants were instructed to respond by pressing the key that corresponded to the location in which the stimulus appeared. They responded to locations A, B, C, and D with their left middle, left index, right index, and right middle fingers, respectively, and were asked to rest their fingers lightly on the keys as they performed the task. Subjects were told to respond as accurately and as fast as possible and the instruction to respond as fast as possible was repeated at the beginning of each block. Participants were told that the location of the stimulus on each successive trial was random. However, for all participants, blocks 2–7 followed a repeating sequence, while only blocks 1 and 8 followed a random sequence. Block 1 functioned as a baseline measure of performance.

Patients performed a practice block and blocks 1–4 in one identity. After this, they were requested to switch to the identity claiming amnesia for experiences in the present of the identity performing the first series of blocks. The switching process was always accomplished in less than 2 min. When the patient confirmed the presence of the second identity, this identity was directly asked if and what she knew of the learning phase and the material the other identity had seen. Patients answered with either "Yes" or "No." The identity subsequently performed a practice block and blocks 5–8. So although at this stage, the procedure allows for the acquisition of new associations by identity 2, what is critical is the activation (or not) of existing procedural memory structures learned by identity 1 in the performance of identity 2. Simulating controls performed blocks 1–4 without simulating, after which they received the following instruction: "You have now performed a task as yourself. We are now asking you to switch to your imagined identity, which will perform the same task you did just now. However, your identity doesn't know you have performed the same task so he or she doesn't know you saw small blocks on the screen and pressed corresponding keys. Your identity thus has no practice in performing this task. So try to start all over again, at the same speed and with the proportion of errors you responded when you started this task as yourself. Your identity has no other difficulties in performing the task. He or she remembers what he/she does and learns and performs as well as any other person. Your identity just doesn't profit from the practice you have had as yourself. Now take a few minutes to let your imagined identity come forward. We will then explain the task to him/her." Subjects then performed blocks 5–8. Normal controls performed all blocks 1–8 including the practice blocks in the same order with a 2-min break after the 4th block to keep the procedure equal.

At the end, we questioned participants about the sequence. We asked them whether they had noted a repeating sequence at any point. If they responded positively, we asked them to type the sequence on the keyboard.

3. Results

Of the 31 DID patients tested, the three patients that reported some explicit knowledge of the study phase in the test phase, either of the material used or of the instructions given to the other participating identity, were left out of the analyses. Two control participants and one patient were left out of the analyses because of extreme high error scores (mean percentage correct responses lower than 80%). The results described therefore pertain to 27 DID patients, 23 control participants, and 25 simulators. The subjects' mean percentage of correct responses and mean RT were calculated for each block, including only those trials in each block on which the subject responded correctly in the RT measure. Results are presented in Fig. 1 and Table 2.

In control subjects, the gradual decrease in mean RT over blocks 2–6 and the increase in RT from blocks 7 to 8 indicated learning of the sequence. Mean RT decreased from 572 ms in block 2 to 453 ms in block 6. Unexpectedly, response times then increased with 9 ms in block 7, possibly reflecting a fatigue effect. As expected, mean response times increased with 52 ms to block 8, when the random sequence was introduced. The mean percentage of correct responses in controls gradually decreased from blocks 2 to 7 (except from blocks 4 to 5, see Table 2) and also decreased from blocks 7 to 8. The decrease in response times compared with the increase in percentage of correct
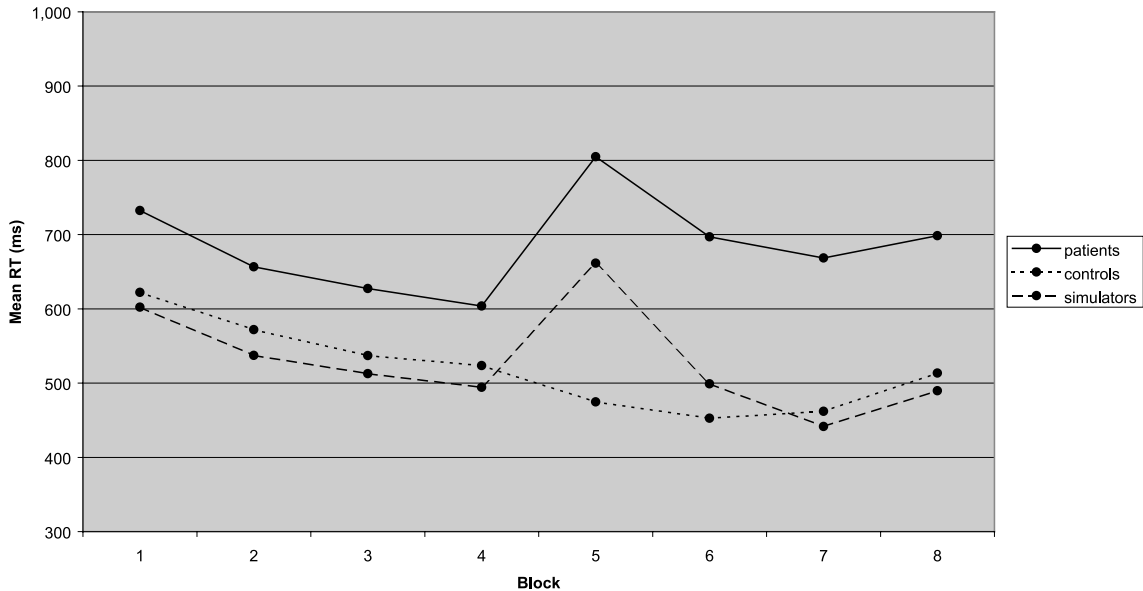
Fig. 1. Mean response times (in milliseconds) in each block for DID patients ($n = 27$), controls ($n = 23$), and simulators ($n = 25$).

Table 2
Mean percentage correct responses in each block for DID patients ($n = 27$), controls ($n = 23$), and simulators ($n = 25$)

Blocks	Group [M (SD)]		
	DID patients	Controls	Simulators
1	97.75 (2.93)	98.37 (1.32)	97.67 (2.38)
2	95.59 (4.11)	95.98 (3.58)	94.03 (4.30)
3	94.57 (3.85)	95.00 (2.85)	91.80 (4.33)
4	94.23 (5.66)	93.44 (3.94)	89.67 (5.79)
5	96.67 (4.63)	93.48 (4.91)	98.23 (1.58)
6	96.48 (3.21)	92.43 (4.40)	95.37 (4.00)
7	95.71 (4.88)	91.70 (5.19)	93.50 (4.29)
8	93.83 (6.50)	88.99 (6.15)	86.83 (8.93)

responses in blocks 2–6 is indicative of an accuracy-speed trade-off, that is, participants respond faster to stimuli but trade this increase in speed for a decrease in accuracy.

In patients, response times decrease from blocks 2 to 4 with 53 ms. Then, after having made the switch to their imagined amnesic identity, their response times increased with 201 ms, after which they again decreased with 137–668 ms in block 7. Finally, response times again increased with 31 ms from blocks 7 to 8 indicating a learning effect. Mean percentages of correct responses decreased from blocks 2 to 4, then increased after the switch, and again decreased from block 5 onwards.

Simulators' RTs and percentages of correct responses showed a pattern comparable to patients. Their response pattern shows a decrease in response times in blocks 2–4, then an increase from

blocks 4 to 5 with 168 ms and again a decrease from blocks 5 to 7. Finally, they also showed an increase from blocks 7 to 8 that is indicative of sequence learning.

A 8 Block × 3 Diagnosis group [patients-controls-simulators] MANOVA on the mean response times revealed that there was a significant Block effect $F(7, 66) = 32.15$, $p < .001$. Within-subjects contrasts, which compare the mean response times in each block except the first block to the mean response times in the preceding block, revealed that mean response times decreased significantly over blocks (all p's $< .001$). The MANOVA also revealed a significant Block × Diagnosis Group interaction $F(14, 134) = 3.97$, $p < .001$. The interaction proved significant only in block 4 vs. block 5 ($p < .001$), block 5 vs. block 6 ($p < .001$), and block 6 vs. block 7 ($p = .001$), the blocks containing a repeating sequence after the switch. While controls thus gave evidence of continuous learning over blocks, patients, and simulators started all over again after their switch to the amnesic identity. The Diagnosis Group main effect was also significant, $F(2, 72) = 13.60$, $p < .001$, indicating that diagnosis groups differed significantly in overall mean response times. Tukey's Honestly Significant Difference (HSD) pairwise comparison procedures indicated that patients differed significantly from control participants ($p < .001$), and from simulators ($p < .001$) with slower responses overall. Controls participants did not differ from simulators ($p = .961$).

A corresponding MANOVA on the mean percentages of correct responses revealed that there was a significant Block effect $F(7, 66) = 21.11$, $p < .001$. Within-subjects contrasts revealed that the mean percentage of correct responses significantly decreased over blocks ($p \leqslant .002$ for all comparisons). The analysis also revealed a significant Block × Diagnosis Group interaction $F(14, 134) = 4.78$, $p < .001$. The Block × Diagnosis Group interaction proved significant only for block 4 vs. block 5 ($p < .001$), block 5 vs. block 6 ($p = .011$), and block 7 vs. block 8 ($p = .001$), the blocks after the "switch," indicating the difference between the continuous decrease in correct responses of control subjects and the sudden increase in correct responses after the switch for patients and simulators. The Diagnosis Group main effect did not reach significance, $F(2, 72) = 3.11$, $p = .051$.

To control for a possible accuracy-speed trade-off, we calculated the correlation between the mean response time in each block and the percentage of correct responses in each block for each subject. We then reanalyzed the data only including subjects with correlations $\leqslant .50$, as indicative for learning free of accuracy-speed tradeoff. Sixteen patients, 13 control subjects, and 13 simulators fulfilled the criterion of a relatively small correlation between response times and percentages of correct responses. Results are presented in Fig. 2 and Table 3. This analysis, however, showed the same pattern of response times, with a significant Block main effect, $F(7, 33) = 19.68$, $p < .001$, and a significant Block × Diagnosis Group interaction $F(14, 68) = 2.12$, $p = .021$. The interaction proved significant only in block 5 vs. block 6 ($p = .011$), and block 6 vs. block 7 ($p = .015$). The interaction from block 4 vs. block 5 did not reach significance ($p = .076$). Again, the pattern we found was that while controls gave evidence of continuous learning over blocks, patients and simulators did not seem to profit from their previous learning experience with the task in their 'amnesic' identity.

3.1. Awareness of the sequence

To the question whether they had noted a repeating sequence at any point, 17 out of 23 controls, 10 out of 25 simulators, and 10 out of 27 patients responded with yes. However, participants
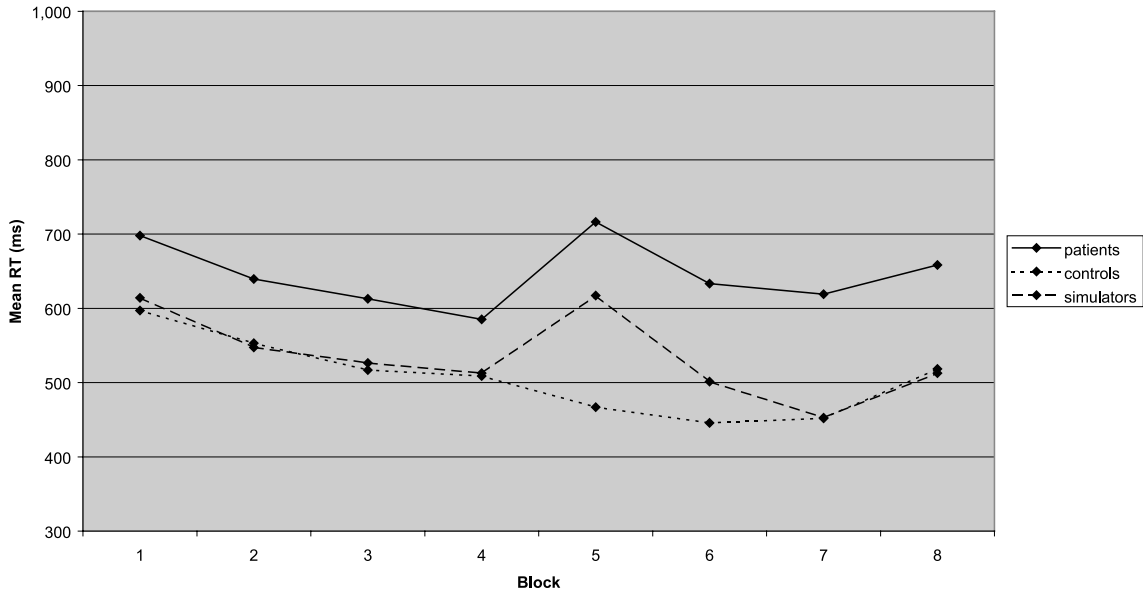
Fig. 2. Mean response times (in milliseconds) in each block for DID patients ($n = 16$), controls ($n = 13$), and simulators ($n = 13$).

Table 3
Mean percentage correct responses in each block for DID patients ($n = 16$), controls ($n = 13$), and simulators ($n = 13$)

Blocks	Group [M (SD)]		
	DID patients	Controls	Simulators
1	97.66 (1.53)	98.40 (1.38)	97.37 (2.86)
2	95.10 (3.73)	97.12 (2.27)	94.42 (4.30)
3	93.65 (4.36)	96.28 (2.09)	92.82 (3.66)
4	93.02 (6.73)	94.87 (2.80)	91.22 (4.31)
5	95.47 (5.52)	95.71 (1.66)	97.69 (1.87)
6	95.42 (3.56)	94.68 (2.84)	95.13 (4.22)
7	94.69 (5.86)	94.04 (4.59)	94.94 (3.70)
8	92.34 (7.83)	89.87 (5.95)	89.23 (6.50)

were not able to describe the procedure used. They differed very much in the number and designation of blocks they thought consisted of sequences. For example, one participant said she thought every block contained a different sequence and another participant thought the first block contained a sequence, while actually this block consisted of a random sequence. Also, several participants thought the sequence only consisted of 2 or 3 trials that were repeated amongst random trials. Two control participants were able to type in a maximum substring of 6 trials in a row out of the 12-trials sequence in among other incorrect trials. Four controls, 5 simulators, and 3 patients were able to type in a maximum substring of four correct trials in a row; 7 controls, 5 simulators, and 2 patients were able to type in 3 trials in a row; and 4 controls and 5 patients were only able to type in 2 trials.

4. Discussion

The purpose of this study was to objectively test procedural memory functioning in DID. Results of control subjects in this study showed the expected decrease in response times over blocks containing a repeating sequence and the expected increase in response times when the stimulus presentation switched from a repeating to a random sequence. It is somewhat difficult to establish what exactly was learned in this task due a possible accuracy-speed tradeoff, even in the low correlation group. Rather than revealing the learning of better predictions of the expected stimulus and response in a repeating sequence trial, a distinctive feature of procedural learning, the pattern may reflect the learning of a faster motor response to the stimulus.

The results of patients showed they responded slower overall as is evident from their increased response times when compared to normal controls and simulators. Secondly, the results of patients seemed to indicate a pattern of inter-identity amnesia, that is, a decrease in response times after their "switch" to their amnesic identity. However, the most important finding in this study is that despite of their lack of explicit processing of the sequence learned in the SRT task, simulators were able to mimic the patient pattern. The measures we took to promote implicit memory processing, that is, the speeded performance instruction, telling the participants the sequence of the trials was random, the 12-trial sequence instead of a the more usual 10-trial sequence, and the increased statistical structure of the sequence, did result in making most of the participants unaware of the nature of the repeating sequence. And those participants who did report noticing a sequence, did not even come close to typing in the correct sequence. Explicit knowledge of the nature of the repeating sequence was thus often completely absent. Importantly, even without this explicit knowledge, simulators were able to slow down their responses comparable to the pattern of inter-identity amnesia that was explained to them was to be expected in DID. Because of the ability of simulators to mimic inter-identity amnesia, the results of patients cannot be interpreted unambiguously. Their pattern of performance can both indicate inter-identity amnesia or simulation of inter-identity amnesia.

In our previous study on implicit memory functioning in DID (Huntjens et al., 2002), we used memory tasks on which simulation by instructed simulators proved impossible. On these implicit memory tasks, no objective evidence of inter-identity amnesia in DID was found. The results of this previous study concur with the two previous studies on procedural memory in DID performed by Dick-Barnes et al. (1987) and Nissen et al. (1988). It would thus be unlikely to expect amnesia on the SRT task employed in this study, also because the SRT task is data-driven and therefore, given the reasoning of Eich et al. (1997a, 1997b) and Nissen et al. (1988), the least expected memory system for amnesia in DID. Speaking against the possibility of amnesia-simulation by patients is a study performed by Eich et al. (1997b), in which simulation of inter-identity amnesia was possible on a picture fragment completion task. On this task, results indicated that patients did *not* try to simulate inter-identity amnesia.

In sum, this study shows that even if measures are taken to reduce or exclude explicit stimulus knowledge, simulation on implicit memory tasks is possible. This conclusion is very important in interpreting results of previous studies and for designing new studies on the subject. Results of all studies on memory in DID not including tasks which are known to be simulation-resistant or not including a control group of DID simulators, cannot be taken as evidence for or against inter-identity amnesia in DID. Simply providing statements that simulation is unlikely on the tasks used certainly does not constitute convincing evidence.

Future studies should thus include memory tasks which are simulation-resistant in order to be able to make definite claims about inter-identity amnesia in DID. Furthermore, tasks on which simulation is easy so that a clear simulation profile can be established should be used in future studies to shed light on the question as to whether patients with DID are simulating their reported memory phenomena. The present results indicate that even without awareness of exactly what is learned procedurally, simulation is possible if subjects possess an advanced enough simulation strategy, which is detailed knowledge about the amnesia profile that is expected of patients.

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