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Assessing markers of working memory function in dissociative identity disorder using neutral stimuli: a comparison with clinical and general population samples

Martin J. Dorahy, Harvey J. Irwin, Warwick Middleton

Objectives: Memory functioning is a central conceptual and phenomenological aspect of dissociative identity disorder (DID). Most empirical work on memory functions in DID has focused on retrieval deficits either within or between dissociated identities. The current study attempted to remedy the scant attention given to working memory functioning.
Method: In samples representing the DID, non-clinical, depressed, posttraumatic stress disorder (PTSD) and psychosis populations (n = 10 per group), neutral stimuli were used to examine three markers of working memory functioning: one measuring inhibition; one assessing facilitation; and one measuring interference.
Results: With the exception of the psychosis sample all groups displayed significant negative priming in the distractor inhibition condition. Facilitation effects were demonstrated by the DID and PTSD groups only. Interference effects were evident in all samples, though the DID and non-clinical groups demonstrated significantly more interference than the psychosis cohort. Distractor inhibition was related to overall schizotypy scores, and dissociation was related to scores in the facilitation condition.
Conclusions: The DID sample displayed a completely distinct functional working memory profile to the psychosis sample when assessed with emotionally neutral stimuli. However, the working memory profile in the DID sample was not entirely dissimilar to the other comparison groups.
Key words: dissociative identity disorder, working memory.

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Dissociative identity disorder (DID) has come under increased empirical scrutiny since dissociative disorders were separated from hysterical neurosis and recognized as free-standing diagnostic categories in DSM-III [1]. Rather than reflecting the genesis of a new area of psychiatric enquiry, contemporary interest in DID signalled a rebirth of ideas and observations from clinicians and theorists like Pierre Janet, Morton Prince and William James who worked around the time of Freud at the turn of the 19th/20th century [2,3]. Despite their primary interest in the phenomenology of DID [4,5], experimental studies were conducted by the pioneers of the dissociative disorders field [6] in an attempt to provide a greater understanding of the nature of DID. In recent times controlled experimental analysis has become increasingly important to researchers studying

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the structural and functional underpinnings of DID [7–13]. Some of this work has focused on retrieval deficits for episodic and semantic information both within and across personality states [14–17; see 18 for review]. Little controlled experimental attention has been given to the function of working memory in DID.

Working memory is generally understood as the construct related to the processing and storage of information in and around conscious awareness [19–21] and subsumes cognitive capacities like attending directly to specific information (selective attention). Given that dissociative episodes entail the disruption of integrated processing and anomalies in memory, perception and consciousness [22–24], all of which involve in one way or another the operation of working memory, DID is likely to be characterized by idiosyncratic working memory functioning. Two questions are central if working memory anomalies exist in DID: (i) what specific working memory processes function anomalously; and (ii) using the terminology of the structural model of dissociation [24], are these functional anomalies identifiable in apparently normal personality (ANP) states (i.e. those disconnected from trauma memories) and when examined under non-threatening conditions, or is their existence only evident when emotional personality (EP) states (i.e. those connected to trauma memories) are tested? It has been argued that 'dissociative tendencies are related to a basic cognitive operation' [25], which suggests the possibility of general functional anomalies in the underlying cognitive architecture of highly dissociative DID participants. We attempt to address the question of whether working memory anomalies at the processing, as opposed to storage or retrieval end of functioning, are part of basic, underlying cognitive operations in DID. Three processing markers of working memory functioning were utilized and experimental stimuli were emotionally neutral. Both non-clinical and psychiatric samples were used as comparison groups for the DID sample. As DID is often misdiagnosed, improvement in assessment and diagnosis will be facilitated by understanding how DID differs at a functional cognitive level from other conditions routinely mistaken for it, and how these functional cognitive differences manifest at a behavioural level.

Experimental procedures have been designed to assess several aspects of working memory performance. For example, the traditional Stroop task measures the degree to which a distracting stimulus disrupts or interferes with the processing of a target stimulus (i.e. the stimulus that requires attention). Interference effects in this task have been found to be greater in non-clinical participants deemed high dissociators by virtue of elevated scores on the Dissociative Experiences Scale (DES) compared to low dissociators [25,26]. However, low dissociators produced a greater level of interference than high dissociators when required to engage in two cognitive tasks simultaneously [25]. These findings suggest that during selective attention tasks (i.e. when only one task is performed) dissociation may be related to greater disruptions in information processing, but as more demands are placed on working memory dissociative ability may relieve to some extent the disruptive consequence that a greater cognitive load would typically have. The condition designed to measure the disruptive effects of competing stimuli on target selection in this study was referred to as *interference*.

In order to reduce the impact of distracting (irrelevant) stimuli during information processing, working memory mechanisms attempt to suppress or inhibit the mental representations of these irrelevant stimuli [27]. By inhibiting the mental representations of distractor stimuli, a target stimulus has greater access to the psychological resources required for effective processing and accurate response. There is considerable evidence to suggest that the ability to cognitively inhibit irrelevant information is weakened in schizophrenia and obsessive-compulsive disorder [28,29]. Despite some recent work challenging the universality of these findings [30,31], reduced cognitive inhibition in schizophrenia has tended to be related to positive or first rank symptoms [32,33], while intrusive thoughts have been linked to weakened inhibition in obsessive-compulsive disorder [33]. Dorahy, Middleton, and Irwin [35] found no evidence of reduced inhibition in a DID sample when using single digit number stimuli, despite the fact that consistent with previous research [36] this sample reported significantly more positive symptoms of schizophrenia than a sample of participants diagnosed with a psychotic illness. However, weakened inhibition was demonstrated in a DID sample when participants were assessed using neutral word stimuli [37]. Dorahy *et al*. [35] tentatively suggested that words may carry a greater potential threat than numbers and perceived threat may interact with the functioning of cognitive inhibitory mechanisms. However, Dorahy *et al*. [35] used a task in which the inhibition of distractor stimuli was not examined in isolation. The current study attempts to remedy this potential methodological limitation.

In the laboratory setting cognitive inhibitory ability can be indexed by tasks designed to evoke negative priming. These tasks require participants to select (attend to) a stimulus they have previously ignored. The degree of retardation in either time or accuracy in this condition compared to a baseline condition where selected information has not been previously ignored, represents a measure of negative priming. A greater

degree of negative priming represents a better ability to engage in cognitive inhibition. The experimental condition designed to measure this aspect of working memory functioning was referred to as *ignored repetition*. The baseline condition minus the ignored repetition condition was deemed a marker of distractor inhibition.

Another marker of working memory functioning is the ability to demonstrate a faster reaction time or greater accuracy (i.e. a facilitation effect) to a target stimulus which was previously presented as a target stimulus. Such an effect, referred to as positive priming, is well established in cognitive psychology [38], but has received scant attention in the study of psychopathology. The condition designed to measure positive priming effects was referred to as *responded repetition*. The baseline condition minus the responded repetition condition was deemed a marker of facilitation.

In this study we used the flanker task to assess working memory functioning. Two trials are presented sequentially as part of each flanker task condition. The first, or prime, trial presents participants with a centrally located target stimulus and two identical distractor stimuli on the flanks (e.g. 3 1 3). Following target response to the middle stimulus participants are presented with another three stimuli. The second, or probe, trial stimuli vary dependent on the nature of the experimental condition. In an ignored repetition condition where distractor inhibition is assessed via negative priming, the distractor stimulus in the prime trial becomes the target stimulus in the probe trial (e.g. 2 1 2 followed by 3 2 3). The responded repetition condition tests facilitatory effects via positive priming in a condition where the target stimulus is repeated in prime and probe trials (e.g. 3 1 3 followed by 2 1 2). Priming effects in these conditions are determined by comparing their mean response times to *probe* target stimuli with the *probe* target response time mean of a baseline condition where prime and probe stimuli are unrelated (e.g. 1 4 1 followed by 3 2 3). Finally, interference effects are assessed by comparing the response latencies to prime target stimuli in conditions which contain congruent (e.g. 3 4 3) and incongruent (e.g. * 1 *) distractors.

The comparison groups for the DID sample were from the general population and three non-dissociative disorder psychiatric populations: major depression, post-traumatic stress disorder (PTSD) and psychosis. These psychiatric groups were chosen because several of their primary symptoms are often evident in individuals with a DID diagnosis [39–41]. For example, the depression symptoms of major depression, the intrusive, avoidance and hyperarousal symptoms of PTSD and the positive symptoms of schizophrenia are consistently reported by individuals with DID. However, dissociative symptoms are far more frequent and severe, and perhaps of a different type, in DID compared to these psychiatric comparison groups [42–44]. Consequently, working memory differences in the DID group are likely to be attributed to dissociation rather than general psychopathology or the specific symptoms that are evident in the comparison groups. It should be noted however, that DID tends to be related to childhood abuse [40] and therefore a measure of childhood trauma was utilized to examine its effect on each of the working memory markers. In addition, a measure of schizotypy was utilized to assess first-rank symptoms, as these have been found to be related to some of the working memory markers investigated here, for example ignored repetition [45].

Our aim in this study was to assess cognitive inhibitory and facilitatory processes, as well as interference effects, in DID. In a previous study, Dorahy *et al*. [35] used a procedure to assess cognitive inhibition that combined the ignored repetition condition with another experimental condition (i.e. attended repetition). For a more sensitive assessment of distractor inhibition, the ignored repetition condition was used in isolation. In line with a previous study which assessed distractor inhibition in DID using single digit stimuli [35], it was predicted that the DID sample would show no evidence of weakened distractor inhibition. However, interference effects were expected to be greater in the DID sample compared to the comparison groups as previous work has found a relationship between interference and dissociation [25,26]. The lack of previous work negated the formulation of a specific hypothesis for facilitatory processes.

Method

Participants

Five groups of participants were recruited to represent the DID, non-clinical, depressed, PTSD and psychosis populations.

Participants in the DID sample were 10 women aged 19–52 years (mean = 37.7, SD = 12.4). The inclusion criteria was a clinical diagnosis and independent structured interview, namely the Dissociative Disorder Interview Schedule (DDIS) [46], diagnosis of DID. Participants were a mixture of inpatients (n = 5) and outpatients (n = 5). All participants reported normal or corrected-to-normal vision. Psychotropic medication was being taking by seven participants, including three on a current course of antipsychotics. Eight participants had been involved in at least one previous study examining cognitive functioning. Dissociative identity disorder participants were instructed before testing to complete the task in their 'host' identity.

The non-clinical group comprised 10 female participants from the general population ranging in age 25–53 years (mean = 38.8, SD = 9.16). Four participants were recruited via a mail-out of medical patients from the practice of a local general practitioner and the other six participants were hospital auxiliary or nursing staff. No non-clinical participant was taking psychotropic medication or reported

either a psychiatric history or visual acuity problems. Two non-clinical participants had taken part in a previous study of cognitive functioning.

Participants in the depressed sample were eight women and two men (n = 10) in either a cognitive behavioural therapy program for depression or in inpatient hospitalization for that condition. The depressed sample was administered the 'major depressive episodes' section of the DDIS to confirm their diagnosis. The sample ranged in age from 22 to 60 years (mean = 46.3, SD = 12.39). All patients were on current courses of antidepressant medication and four were taking antipsychotics. No visual acuity problems were reported.

The PTSD sample comprised three women and seven men (n = 10) either referred to the study by their treating psychiatrist or recruited by virtue of being hospital inpatients. Four participants were Vietnam veterans, and the PTSD criterion A event for the remaining participants ranged from occupational traumas to recreational accidents. The sample ranged in age from 27 to 57 years (mean = 45.9, SD = 9.29). Participants reported either normal or corrected-to-normal vision. All participants in this sample were taking some form of psychotropic medication, with three taking antipsychotics.

Three female and seven male (n = 10) participants were recruited as part of the psychosis sample. Participants suffered either schizophrenia (n = 7) or schizoaffective disorder (n = 3). The age of participants in this sample ranged from 18 to 57 years (mean = 30.0, SD = 14.34). All participants were taking antipsychotic medication. No visual acuity problems were reported in this sample and one participant had been involved in a previous study.

Materials and procedure

The computer task utilized to assess markers of working memory functioning was the flanker task. The flanker task used here presented participants with three horizontally arranged simultaneous stimuli in each trial where the flanker or distractor stimuli were the same and differed from the middle (target) stimulus (e.g. 2 3 2). Participants were required to name as quickly and as accurately as possible the target stimulus. Flanker stimuli were the single digit numbers from 1 to 9; however, the two-syllabled 7 was omitted to ensure the names of all stimuli had only one syllable. The study contained four experimental conditions: ignored repetition, responded repetition and a baseline conditions for each of these (see Table 1). Stimuli for the negative priming conditions (i.e. ignored repetition and its baseline) were the numbers 1–4. Twelve distinct (non-repeated) flanker trial combinations were possible with four stimuli and therefore each negative priming condition contained 12 flanker sets (i.e. prime plus probe conditions). The positive priming task (i.e. responded repetition and its baseline) doubled as a distraction task between each negative priming set. To minimize interference and provide novel distractors, asterisks were used as flanker stimuli (see Table 1). Moreover, to further ensure that the positive priming (distraction) trials were different from the negative priming trials, the numbers between 5 and 9 (excluding 7) were used as target stimuli. Again, 12 trials made up each positive priming condition. Using this design three markers of working memory could be assessed:

- distractor inhibition (negative priming baseline minus ignored repetition);
- facilitation (positive priming baseline minus responded repetition); and;
- interference (prime trials with novel [i.e. *] distractors minus prime trials with number distractors).

Each prime trial was presented for 100 ms (milliseconds) and probe trials were displayed for 150 ms. The longer probe trial displays were thought to reduce the likelihood of top-down episodic retrieval strategies which have been forwarded as an alternative explanation to inhibition for negative priming in ignored repetition tasks [47]. The delay between prime trial response and probe trial display (response–stimulus interval, RSI) was 500 ms.

Reaction times below 200 ms and above 1200 ms were omitted. Moreover, the second standard deviation was calculated for each participant in each condition and outlying data points were adjusted to these figures.

On completion of the flanker task participants were administered the Dissociative Experiences Scale (DES) [48], the Survey of Traumatic Childhood Events (STCE) [49], the Schizotypal Personality Questionnaire (STA) [50] and the Dissociative Disorders Interview Schedule (DDIS) [46]. The DES, STCE and STA were included in the methodology to assess group differences in dissociative and schizotypy experience, and childhood incidences of trauma. Moreover, these measures were included to examine the degree of relationship between dissociation, schizotypy, childhood trauma, and the markers of working memory functioning.

The DES is a 28-item self-report inventory designed to assess dissociative alterations in identity, cognition, and awareness [48]. Items are thought to tap both pathological and non-pathological types of dissociation [43]. With responses being made along an 11-point scale ranging 0–100%, respondents are required to indicate how often they experience each item when free from the influence of alcohol or drugs. Eight items of the DES (known as the Dissociative Experiences Scale-Taxon; DES-T) have been shown to index pathological dissociative tendencies [43]. The total DES and DES-T scores are the means of their respective number of items; thus scores range between 0 and 100. The psychometric utility of the DES has been well attested [51].

Table 1. Examples of experimental stimuli and flanker conditions for inhibition and facilitation

	Negative priming condition		**Positive priming (distractor) condition**	
Trial	Baseline	Ign. Repet	Baseline	Resp. Rep.
Prime	3 1 3	2 3 2	* 9 *	* 8 *
Probe	2 4 2	1 2 1	* 5 *	* 8 *

Ign. Repet, Ignored repetition; Resp. Rep., Responded repetition.

The STCE [49] is a 30-item retrospective measure of childhood and adolescent overwhelming experiences. It surveys a broad spectrum of aversive events, including abuse, parental separation, vicarious and interpersonal violence, and social isolation. Responses are made along a 5-point Likert-type scale ranging from A (never occurred) to E (occurred 10 times or more). To anchor the scale to only childhood events, two changes were made to the original format. The first was an instructional change that asked participants to consider only events occurring before their 13th birthday. Second, item 5 was omitted as it addresses the adolescent experience of abortion.

The STA is a 37-item scale with a dichotomous (yes/no) response format designed around DSM criteria for schizotypal personality disorder [50]. Consequently, it focuses on the positive rather than negative symptoms of schizophrenia and factor analytic work describes three relatively orthogonal factors as magical thinking, unusual perceptual experiences, and, paranoid ideation and suspiciousness [52]. The STA has been used in various studies with clinical and non-clinical samples [45,53].

The DDIS [46] was used to confirm the diagnosis of those in the DID sample and to screen for the undiagnosed presence of DID in the comparison samples. The DDIS is a structured clinical interview assessing for dissociative disorders and related symptoms and conditions, for example, subscales assess Schneiderian symptoms, depression, and features consistent with borderline personality disorder. The DDIS comprises 132 items and has displayed good sensitivity for detecting true cases of DID [54]. Moreover, Kappa coefficients for detecting agreement between clinical judgement and DDIS indications for the presence or absence of DID have been reported at over 0.9 [55]. The current study used three DDIS subscales: features associated with dissociative identity disorder (16 items); dissociative amnesia (3 items); and dissociative identity disorder (4 items).

Statistical analysis

The overall statistical treatment used a multivariate analysis of variance (MANOVA) on three dependent variables (i.e. distractor inhibition, facilitation, and interference) with diagnostic group (i.e. DID, non-clinical, depressed, PTSD and psychosis) as the independent variable. Assessments of group effects within each experimental condition were planned. Group differences across the survey measures were examined with a parametric test (i.e. MANOVA) for the STCE, STA and STA subscales and non-parametric tests (e.g. Kruskall-Wallis) for the DES and DES-T. Spearman's rho was used to examine associations between working memory markers and survey measures.

Results

One participant in the depressed sample was removed for fulfilling diagnostic criteria for DID when assessed with the DDIS. The samples did not differ significantly in terms of age [$F(4,39) = 2.35$]. Non-parametric Kruskall–Wallis tests found no differences across psychiatric groups for overall [$\chi^2(3) = 0.27$] and antipsychotic [$\chi^2(3) = 3.82$] daily dosages of medication.

Questionnaire analysis

Table 2 displays the means, standard deviations and alpha coefficients for each questionnaire across groups.

The groups differed on STCE scores [$F(4,39) = 9.15$, $p < 0.001$] with the DID sample reporting significantly more childhood trauma than the non-clinical ($p < 0.001$), depressed ($p < 0.01$) and psychosis ($p < 0.01$) samples. The Schizotypal Personality Questionnaire scores also produced between-group differences [$F(4,39) = 14.65$, $p < 0.001$] with the DID sample again displaying higher scores than the non-clinical ($p < 0.001$), depressed ($p < 0.001$) and psychosis ($p < 0.05$) samples, but not the PTSD group. With reference to STA subscale scores, magical thinking [$F(4,39) = 4.67$, $p < 0.01$] was significantly higher in the DID sample than the non-clinical ($p < 0.01$) and depressed ($p < 0.05$) groups. The same pattern of results was found for the paranoid ideation and suspiciousness subscale [$F(4,39) = 7.85$, $p < 0.001$] with the DID cohort reporting significantly higher scores than the non-clinical ($p < 0.001$) and depressed ($p < 0.05$) samples. The unusual perceptual experiences subscale [$F(4,39) = 10.15$, $p < 0.001$] showed higher scores for the DID sample compared to all other groups (non-clinical, $p < 0.001$; depressed, $p < 0.01$; PTSD, $p < 0.05$; psychosis, $p < 0.05$).

Non-parametric Kruskall–Wallis tests showed significant between-group differences for the DES [$\chi^2(4) = 31.05$, $p < 0.001$] and DES-T [$\chi^2(4) = 30.11$, $p < 0.001$]. Bonferroni-adjusted post hoc Mann–Whitney tests show that the DID sample had significantly higher DES and DES-T scores than all other groups (DES: non-clinical, z-score = 3.78, $p < 0.001$; depressed, z-score = 3.67, $p < 0.001$, PTSD, z-score = 3.70, $p < 0.001$, psychosis, z-score = 3.18, $p < 0.01$; DES-T: non-clinical, z-score = 3.80, $p < 0.001$; depressed, z-score = 3.68, $p < 0.001$; PTSD, z-score = 3.78, $p < 0.001$; psychosis, z-score = 3.35, $p < 0.01$).

Priming effects

A MANOVA was conducted to examine group differences in experimental effects across each condition and planned one-sample t-tests were conducted to examine group experimental effects within each condition (see Table 3). The omnibus MANOVA statistic (Hotelling's trace) reached significance [$F(12,122) = 1.83$, $p = 0.05$; Eta squared = 0.153]. No differences were found across groups for distractor inhibition [$F(4,44) = 0.60$], but the within-condition tests showed significant negative priming effects in DID [$t(9) = -7.02$, $p < 0.01$], depressed [$t(8) = 6.64$, $p < 0.01$], PTSD [$t(9) = 5.16$, $p < 0.05$] and non-clinical [$t(9) = 6.57$, $p < 0.01$] groups, although not the psychosis sample [$t(9) = 0.58$]. A non-significant result was found between groups for priming effects in the facilitation condition [$F(4,44) = 0.75$]. However, the within-group analysis identified positive priming for the DID [$t(9) = 7.46$, $p < 0.01$] and PTSD [$t(9) = 5.6$, $p < 0.05$] samples. Finally, group differences were found for the interference condition [$F(4,44) = 4.90$, $p < 0.01$], with the DID ($p < 0.01$) and non-clinical ($p < 0.05$) groups showing significantly more interference than the psychosis sample. The within-group analysis showed significant interference effects for all groups [DID, $t(9) = -14.96$, $p < 0.001$; depressed, $t(8) = 17.88$, $p < 0.001$; PTSD, $t(9) = 14.12$, $p < 0.001$; psychosis, $t(9) = 5.14$, $p < 0.05$].

Analysis of relationships

To examine the association between test variables Spearman's rho correlations (r_s) were calculated for the markers of working memory

Table 2. Overall alpha internal reliability coefficients for the survey measures in Study 5 and descriptive statistics across groups

	α		DID	Depression	PTSD	Psychosis	Control
DES	0.97	mean	50.3	11.7	18.3	20.8	4.9
		SD	14.7	7.5	7.6	14.1	4.2
DES-T	0.91	mean	52.6	6.2	9.3	16.4	1.6
		SD	15.3	5.5	6.6	14.5	1.8
STCE	0.87	mean	2.5	1.6	2.0	1.7	1.2
		SD	0.38	0.43	0.74	0.29	0.20
STA	0.93	mean	28.4	13.9	21.7	18.0	6.3
		SD	5.8	7.1	3.9	8.8	3.9
Mag.Th	0.81	mean	5.9	2.6	4.4	4.1	2.2
		SD	1.4	1.8	2.3	2.3	1.7
UPE	0.86	mean	6.5	2.1	3.6	3.1	0.37
		SD	1.9	1.7	1.9	2.8	0.51
PIS	0.76	mean	6.1	3.1	4.2	4.7	1.1
		SD	1.9	2.1	1.2	2.5	1.4

Mag.Th, magical thinking; UPE, unusual perceptual experience; PIS, paranoid ideation and suspiciousness; DID, dissociative identity disorder; DES, Dissociative Experience Scale; DES-T, Dissociative Experience Scale-Taxon; STCE, Survey of Traumatic Childhood Events; STA, Schizotypal Personality Questionnaire, PTSD, posttraumatic stress disorder.

Table 3. Experimental effects across samples for distractor inhibition, deactivated target inhibition, facilitation and interference

	DID	Depressed	PTSD	Psychosis	Non-clinical
Dis.Inh.	–20.28*	–17.43*	–19.16*	–4.20	–16.52*
Facil.	20.92*	7.80	23.54*	20.77	7.19
Interf.	–55.18*	–38.65*	–35.29*	–20.72*	–47.10*

*< 0.05; Dis. Inh., distractor inhibition (i.e. baseline – ignored repetition); Facil., Facilitation (i.e. baseline – responded repetition); Interf., Interference (i.e. prime trial novel distractors – prime trial number distractors).

functioning and the survey measures (n = 49). The DES was significantly related to facilitation ($r = 0.29$, $p < 0.05$), and the STA was associated with distractor inhibition ($r = -0.32$, $p < 0.05$; the negative correlation between these two variables suggest that increases in STA scores are related to greater negative priming). In addition, magical thinking and facilitation were significantly related ($r = 0.39$, $p < 0.01$) as were unusual perceptual experience and distractor inhibition ($r = -0.31$, $p < 0.01$; again, because the degree of distractor inhibition progresses from greater to lesser, the negative correlation suggests a relationship between increases in unusual perceptual experience and more distractor inhibition). With reference to medication, no relationships were found between any of the experimental effects and either overall daily psychotropic drug dosage or antipsychotic daily dosage.

Discussion

This study sought to assess three markers of working memory functioning in DID compared to related psychiatric groups and a non-clinical sample. Consistent with the hypothesized functioning of inhibitory processes, the DID sample showed no evidence of reduced negative priming in the distractor inhibition condition. This is in keeping with previous findings [35] where single digit numbers were also used as experimental stimuli. Facilitation effects were demonstrated by the DID and PTSD samples. Surprisingly, the non-clinical sample displayed no evidence of positive priming in this condition. Finally, all samples produced significant interference effects. However, the hypothesized greater interference in DID was only evident in comparison to the psychosis sample.

The findings from this study suggest that DID is not characterized by weakened inhibitory functioning when assessed using single digit stimuli. In conjunction with the similar results reported by Dorahy *et al*. [35], the

validity of this finding is further supported by the non-clinical sample producing the well-founded negative priming effect [27,38,56] and the psychosis sample displaying their much reported reduction in negative priming for distractor inhibition [28,57]. Expanding from previous work in DID [35], this study examined distractor inhibition in isolation and not in combination with another condition. Consequently, with greater conviction we argue that identity states in DID which are disconnected from trauma material are *not* characterized by cognitive deficits in distractor inhibition during information processing of single digit number stimuli.

Despite not being tested directly here, it is possible that inhibitory functioning for distractor stimuli covaries with an appraisal of the degree of perceived threat present during information processing. As evident here and elsewhere [35], tasks using single digit numbers as experimental stimuli produced significant negative priming in DID for distractor inhibition. However, when common English words are used as test stimuli, disinhibition occurs in DID samples [37]. Subjective reports from DID participants suggest that words, despite their emotional neutrality (e.g. book, chair), produce a more anxiety-provoking experimental context, perhaps because participants were unaware of test stimuli until they were presented in each trial [37, Study 1]. Attempts are currently being made to directly assess the nature of distractor inhibition in both neutral and threatening contexts when DID participants are tested in identities disconnected from trauma memories.

Vital to a thorough understanding of the cognitive underpinnings of DID are studies utilizing either threat-related stimuli or anxiety-provoking experimental contexts. This should be considered the empirical goal of future work in this area. Moreover, such work needs to recognize and cognitively assess dissociative parts of the personality involved in daily living and also dissociative parts of the personality containing traumatic memories (i.e. ANPs, EPs). Differences in working memory functioning is like1y to covary with stimulus type (neutral *vs.* threat), experiential context (non-threatening *vs.* threatening) and dissociative personality type (disconnected *vs.* connected to trauma, ANP *vs.* EP respectively).

Distractor inhibition was related to both overall schizotypy (i.e. STA) scores and paranoid ideation and suspiciousness scores, in that greater negative priming was associated with higher scores on these scales. The inhibition-schizotypy relationship in particular is consistent with other reports [45, studies 2,3]. Yet the DID sample displayed higher STA scores than the psychosis sample but negative priming was evident in the DID group. This finding challenges the view from the schizophrenia and schizotypy literatures that reduced negative priming is related to greater experiences of positive (i.e. Schneiderian) symptoms [32,33,58]. Dorahy *et al.* [35] have provided a more thorough discussion of this issue.

The DID sample displayed higher dissociation scores (as measured by the DES and DES-T) than the other samples, but with the exception of only facilitation, their inhibition and interference results were similar to most other groups. This indicates that in the current study dissociation is not specifically related to the working memory markers assessed here. Further credence is given to this view by the lack of association between dissociation and all markers of working memory functioning except facilitation in the correlational analysis. Impeding a more confident and generalizable conclusion regarding the specific lack of effect dissociation has on the functioning of working memory markers, is the design of this study. Here diagnostic groups acted as the independent variable rather than groups differentiated by their level of dissociative experience. Studies utilizing dissociation as an independent variable in the examination of cognitive interference have found differences between groups reporting high and low levels of dissociative experience [25,26]. Studies of this type will provide a more sensitive assessment of the relationship between dissociation and working memory functioning. In addition, correlational studies of working memory functioning in pathological and non-pathological dissociator samples will help elucidate whether different experiences of dissociation are differentially related to the operations of working memory.

The positive relationship between DES scores and facilitation suggests that increased dissociation is related to increased positive priming ability. But a more thorough account of the actual meaning of this finding is hindered by the failure of the non-clinical sample to display the usual positive priming effect [38] and therefore, the validity of this condition to measure facilitatory processes is brought into question.

In terms of group comparisons across all four experimental conditions, the most immediate conclusion that can be drawn from the findings is that DID has a completely distinct functional working memory profile from psychosis when assessed with emotionally neutral stimuli. The gender differences across the two samples are recognized as a methodological limitation of the current study. Nonetheless, the DID sample showed significant negative priming in the distractor inhibition condition while the psychosis sample displayed no evidence of negative priming. The facilitation condition produced significant results in the DID sample but not the psychosis group. Finally, the DID cohort displayed significantly greater effects in the interference condition than the psychosis group. So even though the phenomenology of

DID is similar to schizophrenia with reference to the presence of Schneiderian symptoms [39,36], their underlying working memory function diverges. These findings have clear implications for clinical observations and assessment that may feed into an accurate differential diagnosis of DID and psychosis. For example, the weakened distractor inhibition in the psychosis sample is likely to manifest as increased distractability, and possibly agitation, when an individual with a psychotic illness is assessed. Alternatively, the ability to engage in effective inhibition is likely to lead to less observable distractability on assessment in an individual with DID who is presenting in an identity detached from trauma memories. Such observations may be helpful in coming to a correct diagnosis and as a result a suitable and effective treatment strategy.

In conclusion, this study sought to examine three distinct markers of working memory functioning in DID compared to clinical comparison groups and a non-clinical sample. Neutral (non-emotive) stimuli were used to provide a 'baseline' picture of the functioning of working memory under non-stressful conditions and in personality states that were geared towards activities of daily living. In the main, the DID sample showed results relatively similar to other groups, but were most distinct from the psychosis sample, in that the DID group displayed distractor inhibition and facilitation, while the psychosis sample failed too. Moreover, the DID sample produced significantly more interference than the psychosis group. Using these indicators, future research can examine whether functional differences in working memory are evident in DID samples when assessed with emotionally arousing or threatening stimuli, or in states connected to traumatic memories. Such work will pave the way for a more accurate theoretical understanding of the cognitive underpinnings of DID.

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