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Impact of Diagnosis Threat on Neuropsychological Assessment of People with Acquired Brain Injury: Evidence of Mediation by Negative Emotions

Megan Fresson[1,*], Benoit Dardenne[2], Thierry Meulemans[1]

[1]*University of Liège (Belgium), Psychology and Neurosciences of Cognition Unit, Place des Orateurs 1, 4000 Liège, Belgium*
[2]*University of Liège (Belgium), Psychology and Neurosciences of Cognition Unit, Place des Orateurs 2, 4000 Liège, Belgium*

*Corresponding author at: Psychology and Neurosciences of Cognition Unit (B33 Trifacultaire – Quartier Agora), Place des Orateurs 1, 4000 Liège, Belgium. Tel.: +32-4-366-23-99; fax: +32-4-366-28-75.
E-mail address: megan.fresson@ulg.ac.be

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Abstract

Objective: Some studies have shown that diagnosis threat (DT) could negatively impact the cognitive performance of undergraduate students who had sustained a mild traumatic brain injury. This study was designed to examine DT in people with acquired brain injury (ABI). As a second goal, we investigated the effect of stereotype lift as a way to overcome DT's harmful impact. The purpose of this study was also to examine the mechanisms mediating stereotype effects.
Method: People with ABI and control participants were assigned to one of three conditions: DT, cognitive-neutral (in which the cognitive status of participants with ABI and the cognitive characteristics of the tasks were deemphasized), and stereotype lift (in which a downward comparison was made with another neurological group). Participants then completed neuropsychological tasks. Negative emotions, intrusive thoughts, task expectancy, and self-efficacy were assessed for mediation analyses.
Results: Instructions impacted the performance of people with ABI, but not control participants. Compared to the cognitive-neutral condition, participants with ABI in the DT condition performed worse on memory and executive tasks (but not on attention tasks). These effects were mediated by negative emotions. There was no increase in performance in the stereotype lift condition compared to the DT condition.
Conclusions: This study showed that DT can aggravate the cognitive difficulties of people with ABI during neuropsychological assessment. The mediating role of negative emotions and the selective impact of DT on tasks that rely heavily on executive functioning are discussed in the light of the stereotype threat model.

Keywords: Assessment; Cerebrovascular disease/accident and stroke; Head injury; Traumatic brain injury; Professional issues

Introduction

Acquired brain injury (ABI) can result from both traumatic (e.g., traumatic brain injury; TBI) and non-traumatic (e.g., encephalitis) etiologies. ABI applies to individuals whose neurological development was normal until they acquired brain damage (Teasell et al., 2007). ABI can result in physical, (neuro) psychological, and emotional problems that induce limitations in the day-to-day functioning (Tagliaferri, Compagnone, Korsic, Servadei, & Kraus, 2006). Regarding neuropsychological capacities, outcomes following ABI have been found to vary substantially across individuals (Goldstein, Allen, & Caponigro, 2010; Millis et al., 2001). Although many studies have been conducted to determine the influence of physiological brain variables on neuropsychological functioning, emotional and motivational factors had been also found to influence recovery (Belanger, Curtiss, Demery, Lebowitz, & Vanderploeg, 2005; Chamelian & Feinstein, 2006; Gauggel, Hoop, & Werner, 2002). Other than the impact of physiological and emotional factors, very few studies have been conducted to examine the impact of psychosocial factors on the neuropsychological performance of people with ABI: among these factors are stereotypes regarding people with ABI.

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The cognitive performance of a wide range of individuals (e.g., women, older people, and African Americans) has been found to decrease if a stereotype (e.g., "Women are bad at math") about their alleged inferiority is activated (Spencer, Logel, & Davies, 2016). This phenomenon is called stereotype threat (Steele & Aronson, 1995).

In order to study this psychosocial phenomenon in individuals with mild TBI (mTBI), Suhr and Gunstad (2002) asked over 2,000 undergraduates students to complete a screening process including different questionnaires. Only participants reporting a past history of mTBI were recruited. Half of the participants did not know why they were recruited and were simply invited to participate in a neuropsychological study. The other half were told that their mTBI was the reason for their inclusion and that the study's purpose was to investigate the negative impact of mTBI on neuropsychological outcomes. The results showed that participants for whom the negative stereotype about mTBI was activated underperformed on several neuropsychological tests compared to their counterparts in the neutral condition. The authors called this phenomenon "diagnosis threat" (DT). To date, only six studies have been published on DT with undergraduate students who had suffered from mTBI. In addition to the study by Suhr and Gunstad (2002), only two studies have found that DT impacted cognitive performance (Pavawalla, Salazar, Cimino, Belanger, & Vanderploeg, 2013; Suhr & Gunstad, 2005). Other studies found no impact of DT on cognitive performance (Blaine, Sullivan, & Edmed, 2013), but did find an impact on cognitive self-assessment (Ozen & Fernandes, 2011) or academic self-efficacy (Trontel, Hall, Ashendorf, & O'Connor, 2013). Overall, then, the results are mixed, and some authors have suggested that DT is more likely to impact subjective measures than objective performance (Ozen & Fernandes, 2011).

However, all these studies were conducted with undergraduate students who had sustained mTBI in the past, and who supposedly did not present cognitive disorders related to the mTBI any longer. A recent study has investigated the effect of DT on more representative samples of participants with TBI. Kit, Mateer, Tuokko, and Spencer-Rodgers (2014) recruited individuals who had sustained a mild to moderate TBI from the Victoria, British Columbia, community. These participants were recruited from cognitive rehabilitation centers or through clinicians. Participants were allocated to a reduced threat condition or a heightened threat condition. In the reduced threat condition, the instructions both diminished DT cues (by emphasizing time-based recovery) and reinforced feelings of control over cognitive functions. In the heightened threat condition, instructions both reinforced DT cues (by emphasizing limits on recovery) and minimized control beliefs. The results showed that participants in the reduced threat condition outperformed participants in the heightened threat condition on attention and initial encoding (memory) scores.

The study by Kit et al. (2014) suggested that DT is more likely to impact the cognitive performance of "true" neurological patients compared to undergraduate students who report an mTBI sometime in the past. People who have acquired the status of "patients" and who have to be medically monitored for a period of time after their brain injury (which is generally not the case for mTBI) may be more vulnerable to DT's effects. Although the study by Kit et al. opened the way towards a better understanding of the impact of DT in a non-student sample, most of their participants with TBI had suffered from an mTBI (76%); moreover, they did not differ from the neurologically normal participants on cognitive tasks. Their sample of participants with TBI might, then, not have been representative of people with ABI who have cognitive difficulties. Therefore, further studies should be conducted with participants with ABI who are engaged in medical and rehabilitation follow-up due to neurological disorders.

A second limitation refers to the addition of DT (or not) and the reduction (or amplification) in feelings of control in the instructions, which prevents one from disentangling the contribution made by each factor. The effects observed by Kit et al. (2014) could be driven solely by the manipulation of feeling of control. This limit is linked to the difficulty of setting a "neutral" condition for people with ABI recruited in medical settings. People with ABI asked to complete neuropsychological tasks may well automatically associate the testing situation with their neurological history. In the more general stereotype threat literature, authors have overcome this kind of difficulty by varying the *diagnosticity* of the tasks. For example, in the study by Desrichard and Kopetz (2005), in the diagnostic condition, a memory task was presented as such to older people (therefore matching the stereotype that seniors have memory problems), while in the non-diagnostic condition, participants were told that the task they would complete measured their orientation capacities. Their results showed that, after the memory-emphasizing instructions (diagnostic condition), older persons underperformed on the task compared to participants in the orientation-emphasizing task (non-diagnostic condition) (see also Rahhal, Hasher, & Colcombe, 2001).

In addition to the effect of non-diagnostic instructions on performance maintenance, another way to overcome the deleterious impact of stereotype threat could rely on outperformance effects due to "stereotype lift" (Walton & Cohen, 2003) and "stereotype boost" (Shih, Pittinsky, & Ho, 2012). Compared to a stereotype threat condition, stereotype boost or lift instructions have been shown to enhance performance. While outperformance following stereotype boost is due to the activation of an in-group positive stereotype, with stereotype lift it comes from the activation of an out-group negative stereotype (Shih et al., 2012). Despite this important distinction, the two phenomena probably work together, since activating a positive in-group stereotype generally triggers a negative out-group stereotype (e.g., if "men are good at math," then "women are bad at math"). For example, it has been shown that the math performance of male participants increased when their male identity was made salient (McGlone & Aronson, 2006) but decreased when their "White" identity was made salient (compared to Asian people, who are reputed to excel in math) (Aronson et al., 1999). It has been proposed that the beneficial impacts of both stereotype lift and stereotype boost on performance result from (downward) comparison (Shih et al., 2012). To our knowledge, no study has yet investigated stereotype lift or boost in people with ABI as a way to overcome the detrimental impact of DT on performance. Compared to a DT condition, one can expect that people with ABI would perform better in a stereotype lift condition.

Regarding studies conducted with undergraduate students with a past history of mTBI, none discovered the mechanisms underlying the DT effect (Pavawalla et al., 2013; Suhr & Gunstad, 2002, 2005). However, in Kit et al. (2014) study, the results indicated that the negative effects of the heightened threat condition were mediated by self-efficacy: the heightened threat condition triggered lower memory self-efficacy, which led to poorer performance. They found no evidence of mediation by anxiety, motivation, or dejection-related emotions. Several potential mediators have been investigated in the stereotype threat literature. In particular, the role of negative emotions and intrusive thoughts has been highlighted: stereotype threat triggers negative emotions and intrusive thoughts (e.g., negative thinking about one's own performance and mind wandering). Consequently, people try to suppress this negative emotional state, and these suppression processes (self-regulation) consume working memory and executive function capacities. In turn, this depletion of executive resources impedes performance (Schmader, Johns, & Forbes, 2008). As well, performance expectancy has been found to mediate the underperformance observed in stereotype threat conditions: people under stereotype threat expect poorer test results, which in turn leads to poorer task performance (e.g., Cadinu, Maass, Frigerio, Impagliazzo, & Latinotti, 2003; Desrichard & Kopetz, 2005). Finally, several authors have highlighted the need to consider several mediators simultaneously when examining stereotype effects (Schmader et al., 2008; Smith, 2004).

The main goal of this study was to investigate the impact of DT on a more representative population of people with ABI, namely people engaged in medical follow-up due to their neurological problems. Moreover, this study aimed to examine the specific impact of DT compared to a non-diagnostic condition (in which the cognitive characteristics of the tasks are deemphasized). As well, we were interested in studying the potential beneficial effect of stereotype lift on people with ABI. To do this, participants were assigned to one of the three following conditions: a DT condition; a cognitive-neutral condition in which participants were told they would be given visual and auditory tasks; or a stereotype lift condition in which they were told that the study's purpose was to examine the more severe impact of Alzheimer's disease on cognitive performance compared to other neurological conditions. We hypothesized that, compared to the DT condition, participants in the neutral-cognitive and stereotype lift conditions would perform better. Finally, we expected that the negative impact of DT would be mediated by an increase in negative emotions and intrusive thoughts and a decrease in task expectancy and self-efficacy compared to the neutral-cognitive and stereotype lift conditions.

Method

Participants

We recruited both participants with ABI and control (neurologically normal) participants matched for age and years of education. The recruitment of participants with ABI was conducted within several cognitive rehabilitation units in Belgium. We recruited participants with ABI who had sustained a TBI (from mild to severe), a cerebrovascular accident or another non-degenerative neurological condition (e.g., anoxia). Severity of TBI and neurological conditions were confirmed by patient's medical record. Their age ranged from 17 to 55 years old and all participants had completed at least elementary school. All participants were undergoing a cognitive rehabilitation program at the time we met them due to cognitive deficits diagnosed by a neuropsychologist. Most of them were outpatients and the time elapsed since injury ranged from 3 to 77 months. Exclusion criteria were neurological or non-neurological auditory or visual disorders, including unilateral neglect and hemianopia (participants had to have normal or corrected hearing and vision); an ongoing psychiatric condition (e.g., alcoholism, depression, etc.); and hand motion problems (so they could complete neuropsychological tasks). Control participants were recruited with the snow-ball technique and satisfied the same exclusionary criteria than participants with ABI (no auditory or visual disorders, no ongoing psychiatric conditions, and no hand motion problems). In addition, control participants could not report any past or present neurological condition. Control participants were recruited in order to match the participants with ABI for age and years of education (and gender when possible). Specifically, when a participant with ABI was enrolled in the study, a control participant of approximately the same age, the same number of succeeded education years and when possible the same gender was assigned to the same experimental condition than the matched participant with ABI.

A priori power analysis indicated that we needed to have at least 50 subjects in each of our two groups of participants to have 80% power for detecting a medium sized effect of the experimental manipulation ($f^2 = .15$) when employing the traditional .05 criterion of statistical significance (G*Power; Faul, Erdfelder, Buchner, & Lang, 2009). Consequently, we recruited 106 participants (53 ABI and 53 control participants). For both groups, there were 18 participants in the DT and cognitive-neutral conditions, and 17 participants in the stereotype lift condition.

Material

Neuropsychological tasks. Because the participants in one condition (neutral-cognitive condition) had to believe that the tasks assessed visual and auditory processing, we could not use clinical neuropsychological tasks that they had already completed (i.e., clinical cognitive tasks). We therefore either adapted already administered tasks to make them not "recognizable" by emphasizing visual and auditory processing (less diagnostic) or selected experimental tasks (Because participants were recruited from different rehabilitation centers and neuropsychologists in each of these centers used to administer different neuropsychological tasks, we cannot establish a protocol of alternative tasks that were not yet administered to our participants. In general, tasks were adapted to emphasize visual and/or auditory processes involvement (for example, by adding colors, replacing treatment of numbers by treatment of shapes and colors, adding noisy background to the episodic memory task, etc.).). The tasks assessed memory, executive, and information processing speed capacities. The neuropsychological tasks were administered after participants had received the experimental instructions depending on their assigned experimental condition.

Information processing speed tasks—*The adapted Go/No-Go subtest of the Test of Attention Performance* (*TAP*; Zimmermann & Fimm, 2010). During this selective attention computerized task, participants had to press the response button as quickly as possible when one of six circles became blue or pink. The index of performance was the median response time (RT).

The adapted divided attention subtest of the TAP (Zimmermann & Fimm, 2010). During this computerized task, participants had to press the response button as quickly as possible if either a circle appeared at the center of a pattern of lines or there was a break in a chronological series of sounds. The index of performance was the median RT for visual and auditory stimuli.

Letter comparison task (Salthouse, 1996). In this computerized task, participants had to press one of two response buttons as quickly as possible if two adjacent letters were identical and the other response button if the two letters were different. The index of performance was the median RT.

Memory tasks—*Token test* (De Renzi & Vignolo, 1962). After the participants heard an instruction (e.g., "Point at one red circle, and then a small blue object"), a page with 20 objects appeared on the screen. The items differed in shape (circle or square), color (red, blue, white, green, or yellow) and size (small or big). Participants had to follow the instructions by pointing at the corresponding objects. The performance index was the number of correct responses.

The word list test. During this computerized task, participants heard a list of 12 disyllabic words five times with five different noisy background sounds. After each trial, participants were asked list tell all the words they had heard. The index of performance was the total number of correct responses during the five trials.

Supraspan Task (Meulemans, 1997). During this task, a grid with 12 occupied squares appeared five times on the screen for 2 s. After each presentation, participants had to reproduce the occupied squares on a blank paper grid. The index of performance was the total number of correctly crossed out squares through the five trials.

Executive tasks—*Adapted sustained attention to response task* (Robertson, Manly, Andrade, Baddeley, & Yiend, 1997). During this inhibition task, colored rectangles appeared briefly (500 ms) on the computer screen. There were nine different colors. Participants had to press the response button as quickly as possible for each rectangle except for the blue one. The performance index was the total number of correct responses.

Tone monitoring task adapted from Miyake et al. (2000). During this computerized updating task, participants heard sequences of low and high tones. They had to press the response button for each fourth occurrence of the low and high tones. There were four sequences of 25 tones. The performance index was the total correct responses across the four sequences.

Shape-color task adapted from the number-letter task (Miyake et al., 2000). In this computerized flexibility task, colored shapes appeared on one quadrant of the screen. Depending on the top or bottom position, the participants' task varied. If the colored shape appeared in an upper quadrant, participants had to decide if the shape was angular or not by pressing the yes or no button. If the colored shape appeared in one of the bottom quadrants, participants had to decide if the shape was a single color or not by pressing the corresponding yes/no button. The performance index was the number of correct responses.

Data reduction. Because we had multiple performance indices and in order to avoid type I errors, we calculated three composite scores (by averaging z-scores based on data from the existing samples), each corresponding to a particular cognitive function: processing speed, memory, and executive functioning. We calculated a composite processing speed score by averaging (reversed) z-scores of the median RTs of the Go/No-Go subtest, the divided attention subtest, and the letter comparison task (rs > .55, ps < .001). We calculated a composite memory score by averaging z-scores of the total correct responses during the token test, the word list test, and the supraspan task (rs > .25, ps < .01). Finally, we created a composite executive score by averaging z-scores of the total correct responses during the sustained attention to response task, the tone monitoring task, and the shape-color task (rs > .48, ps < .001). For the three composite scores, the higher the score, the better the performance.

Mediator assessment. The following questionnaires were administered to assess mediating mechanisms.

The "mood state" and "thinking content" subscales of the Dundee Stress State Questionnaire (DSSQ; Matthews, Warm, Reinerman, Langheim, & Saxby, 2010)—The mood state subscale (Cronbach's alpha = .90) requires participants to assess their mood state when they were completing the neuropsychological tasks. For each adjective (negative and positive), participants responded using a 4-point Likert scale (from "definitely" to "definitely not"). This scale assesses energetic arousal (e.g., unenterprising), tense arousal (e.g., nervous), hedonic tone (e.g., dissatisfied), and frustration (e.g., irritated). Higher scores represent more negative mood states. The thinking content subscale (Cronbach's alpha = .79) requires participants to report the occurrence of intrusive thoughts while they were completing the neuropsychological tasks. Participants responded using a 5-point Likert scale (from never to very often). Higher scores represent more frequent intrusive thoughts. The DSSQ had been found to exhibit good psychometric properties, especially it has been found to predict objective performance (see Matthews, Szalma, Panganiban, Neubauer, & Warm, 2013).

Task expectancy measure—To measure task expectancy, we used the same single item as Desrichard and Kopetz (2005) by asking participants how they expected to perform. Participants respond using a 7-point Likert scale from "very poor performance" to "very good performance."

Self-efficacy questionnaire—This questionnaire (Cronbach's alpha = .88) was adapted from the capacity subscale of Dixon and Hultsch (1983) Metamemory In Adulthood (MIA) questionnaire. It comprises 20 items assessing feelings of efficacy regarding memory and concentration (e.g., "I am good at remembering names"). Participants respond using a 5-point Likert scale ranging from "totally agree" to "totally disagree." Higher scores represent higher feelings of self-efficacy. The MIA showed good psychometrics properties (see for example, Hertzog, Dixon, Schulenberg, & Hultsch, 1987) and had been used in several stereotype threat studies (see for example Bouazzaoui *et al.* 2016).

Baseline tasks. During a second session when no stereotypes were activated, we administered two neuropsychological tasks to ensure equivalence between conditions regarding cognitive level. As well, we administered a non-verbal reasoning task from the Wechsler Adult Intelligence Scale – fourth edition (WAIS-IV; Wechsler, 2008) to ensure equivalence between groups and conditions regarding premorbid intellectual level.

Verbal paired associates subtest of the Wechsler Memory Scale – fourth edition (WMS-IV; Wechsler, 2009)—During the encoding phase, participants had to learn 14 pairs of words through four trials. During the recall phase, the experimenter said the first word of each pair and participants had to recall the word associated with each one.

D2 test (Brickenkamp, 1998)—In this paper-and-pencil selective attention task, participants had to cross out as many targets (a letter "d" with exactly two dashes around it) as possible in a limited time. The targets were displayed within a set of distractors (letter "d" with more or fewer than two dashes or letter "p" with one to four dashes).

Matrix subtest of the WAIS-IV (Wechsler, 2008)—This non-verbal reasoning task required participants to complete sequences of visual items. It was administered to assess premorbid intellectual level.

Procedure

The study was approved by the Ethics Committee of the University of Liège (Belgium) and the Ethics Committees of the different cognitive rehabilitation centers that participated in the recruitment. This study was conducted in two sessions. Note that the second session was scheduled for the purpose of another study, but data for the present study were also collected at this point (see below for further explanations). The first session was conducted with two experimenters to ensure double-blind testing. After the participants gave their written consent, experimenter A administered two sensory tests to all participants: the Monoyer test (reading letters of decreasing size at a distance of 3 m) and a false computerized sound detection test (sounds of increasing volume were presented to participants and they were asked to respond as quickly as possible when they started to hear something). Participants were told that these tasks' purpose was to ensure correct (or corrected) basic hearing and vision capacities. This sensory "screening" was conducted to increase the credibility of the study's alleged purpose for participants in the neutral-cognitive condition.

Then, participants who had been randomly assigned to one condition received specific written instructions from experimenter A. Control participants were assigned to the same condition as their matched participants with ABI, except that instructions in the DT and stereotype lift conditions were adapted for them. The instructions are presented in Appendix 1. Participants with ABI in the DT condition were informed that they were selected because of their neurological condition and that the purpose of the study was to examine their cognitive issues. Participants in the neutral-cognitive condition were informed that they had been recruited because they had correct hearing and vision and that the purpose of this study was to study sensory processing. We had conducted a preliminary survey with 62 neurologically normal participants who completed a questionnaire about people with brain injuries. Only eight of these individuals indicated that hearing and vision were “altered” or “totally altered.” Thus, hearing and visual deficits are not part of the stereotype about ABI, reassuring us that our instructions would not activate a negative stereotype. Participants with ABI in the stereotype lift condition read that they were recruited because they did not have Alzheimer’s disease and that the purpose was to study the greater negative impact of Alzheimer’s disease on cognitive functions compared to non-degenerative neurological conditions. Since Alzheimer’s disease is a degenerative condition with a bleak future and no possibility of recovery (contrary to ABI) and this neurological condition is known to elicit catastrophic fears (French, Floyd, Wilkins, & Osato, 2012), we expected that these instructions would result in downward comparisons.

Then, experimenter A left the testing room and experimenter B administered the tasks and questionnaires to participants in the following order. Participants first completed the Go/No-Go task, the letter comparison task, the task expectancy measure, the token test, the supraspan task, the tone monitoring task, the sustained attention to response task, the divided attention task, the shape-color task, and the word list test. They were then given the mood state and thinking content subscales of the DSSQ and the self-efficacy questionnaire. Finally, participants completed a manipulation check measure to ensure they remembered the purpose of the study. After the token test and the sustained attention to response task, participants were given a break. Experimenter A systematically left the testing room and Experimenter B asked participants to recall specific extracts (mean length of 63 words) of the instructions presented in the Appendix.

Because we needed to have cognitive performance not biased by (stereotype) instructions to ensure equivalence between groups regarding cognitive status, we administered baseline tasks during a separate session scheduled for another study. Ideally, these baseline tasks should be administered during the first session and just before the experimental instructions. However, these baseline tasks have high face validity, especially the verbal paired associates subtest of the WMS-IV (Wechsler, 2009). That certainly would have jeopardized the credibility of our neutral instructions (hearing and vision assessment). Consequently, during a “second” session (7–10 days after the first session), after responding to demographic questions (years of education, etc.), participants were given different questionnaires (e.g., anosognosia questionnaire) for the purpose of another study (which was conducted with no stereotype instructions). After that, they completed the three baseline cognitive tasks in the following order: the encoding phase of the verbal paired associates subtest, the D2 test, the matrix subtest, and the recall phase of the verbal paired associates subtest. Then, these baseline tasks were not administered in the context of stereotype activation.

Results

Demographic and Baseline Data Analyses

We first analyzed demographic and baseline data to ensure equivalence across groups and conditions. The results of a Group (Control vs. ABI) × Condition (DT vs. Neutral-cognitive vs. Stereotype Lift) ANOVA showed no effect of age (*ps* > .276), years of education (*ps* > .142), or matrix score (*ps* > .152), indicating that participants in all three conditions were equivalent regarding intellectual level and age. Regarding baseline cognitive scores, as expected, the results showed a group effect on the WMS-IV ($F(1, 100) = 14.6$, $p < .001$) and the D2 test ($F(1, 100) = 30.7$, $p < .001$), with participants with ABI scoring lower on these tasks. More importantly, there was no interaction between group and condition, nor an effect of condition on these scores (*ps* > .179). Thus, for participants with ABI, there was no between-conditions difference regarding cognitive status (see below for injury-related characteristics). Chi-square tests indicated no gender difference between groups and conditions (*ps* > .224).

Regarding the ABI group, an ANOVA using condition as between-subjects factor indicated no difference between conditions regarding the time elapsed since injury ($p = .444$). As indicated by a Kruska–Wallis non-parametric ANOVA, there was no difference between conditions regarding the kind of ABI ($p = .531$) or its severity ($p = .276$). Also, there was no difference between conditions regarding in- or outpatient status ($p = .585$) (Table 1).

At the end of the first session, participants completed a manipulation check measure to ensure they understood and remembered the instructions. Analyses of the manipulation check items showed that participants in the cognitive-neutral condition agreed significantly more with the items “the tasks assessed hearing and vision” ($F(1, 103) = 5.94$, $p = .017$) and “the goal of this study was to assess hearing and vision” ($F(1, 103) = 31.46$, $p < .001$) than participants in the other two conditions (combined) (On the item “the tasks assessed hearing and vision”, participants with ABI in the neutral condition had a mean response of 5.83 (SD = 1.62) on the 7-point likert scale (7 = totally agree). On the item “the goal of this study was to assess hearing and vision”, participants with ABI in the neutral condition had a mean response of 6.06 (SD = 1.11) on the 7-point Likert scale. Note that none of our participants with ABI disagreed (scored less than the neutral point – 4) on both items.). Participants in the stereotype lift and DT conditions agreed significantly more with the item “the tasks assessed memory and concentration” than participants in the cognitive-neutral condition ($F(1, 103) = 7.70$, $p = .007$). Participants in the DT condition agreed significantly more with the idea that the purpose of the study was to compare task performance of people with and without ABI than participants in the other two conditions ($F(1, 103) = 22.45$, $p < .001$). Finally, participants in the stereotype lift condition agreed significantly more with the idea that the aim of the study was to compare their results to those of people with Alzheimer's disease than the other two groups ($F(1, 103) = 103.43$, $p < .001$).

Impact of Instructions on Cognitive Performance of People with ABI

We first examined the interaction between condition and group on the three cognitive scores with the hypothesis that the performance of participants with ABI would be better in the cognitive-neutral and stereotype lift conditions than in the DT condition. The performance of control participants was expected not to be influenced by condition. We therefore conducted regression-based analyses with condition and group as predictors on the three dependent cognitive scores.

Regarding group, participants with ABI were contrast-coded +1 while control participants were contrast-coded −1. Due to our multicategorical independent variable (i.e., three conditions), we used dummy coding (or indicator coding) as recommended by Hayes and Preacher (2014) and Hayes and Montoya (2017). Since we had three conditions, we created two dummy codes in which the DT group was set as the reference group (coded 0 on each dummy code, d1 and d2). Consequently, each effect in the analysis has to be interpreted relative to this reference group. The cognitive-neutral condition was coded 1 on d1 and 0 on d2 and the stereotype lift condition was coded 0 on d1 and 1 on d2. Therefore, d1 tested for the difference between the neutral-cognitive instructions and the DT condition, while d2 examined the difference between the stereotype lift condition and the DT condition. Since we wanted to determine whether there was an effect of condition only for the ABI group, we conducted separate ordinary least squares regressions in which each cognitive score was estimated from d1, d2, and group (as moderator), as well as the interactions between d1 and group and between d2 and group.

Executive score. There was a significant effect of group (in the DT condition) ($b = -.52$, $SE = .12$, $t = -4.23$, $p < .001$, 95% CI = [−.76, −.27]) and d1 ($b = .50$, $SE = .17$, $t = 2.92$, $p = .004$, 95% CI = [.16, .85]) on performance. Most interestingly, the interaction between group and d1 was significant ($b = .39$, $SE = .17$, $t = 2.27$, $p = .026$, 95% CI = [.05, .73]). When we probed this interaction, the results revealed that participants with ABI in the cognitive-neutral condition performed better on executive tasks than participants with ABI in the DT condition ($b = .90$, $SE = .24$, $t = 3.67$, $p < .001$, 95% CI = [.41, 1.38]). There was no effect of d1 for control participants ($p = .646$) (see Fig. 1). There was no effect of d2 ($p = .220$), nor any significant interaction between group and d2 ($p = .284$). Regarding d2, no specific contrasts was significant ($ps > .106$).

Table 1. Demographic and baseline data and injury-related characteristics

	Control			ABI		
	Diagnosis threat ($n = 18$)	Neutral-cognitive ($n = 18$)	Stereotype lift ($n = 17$)	Diagnosis threat ($n = 18$)	Neutral-cognitive ($n = 18$)	Stereotype lift ($n = 17$)
Age	37.7 (12.9)	32.9 (11.2)	35.9 (10.9)	38.0 (12.1)	34.1 (10.5)	36.2 (10.3)
Education	12.3 (2.6)	13.9 (2.1)	13.6 (2.8)	12.2 (2.1)	13.1 (2.8)	12.6 (3.4)
Gender	55.6	61.1	41.2	50	55.6	35.3
Matrix	18.1 (5.0)	19.4 (4.2)	19.9 (4.5)	16.3 (5.7)	18.8 (4.5)	18.3 (5.1)
D2*	169.9 (45.5)	193.6 (39.6)	185.5 (53.8)	126.6 (46.2)	143.4 (47.4)	130.7 (41.8)
WMS-IV*	12.8 (2.1)	12.7 (2.3)	12.2 (2.1)	10.3 (3.5)	11.3 (3.1)	9.5 (3.9)
TSI				20.3 (20.1)	13.6 (6.8)	17.1 (17.2)
TBI				66.67	77.78	82.35
Mild				11.11	27.78	17.65
Moderate				5.56	11.11	0.0
Severe				50.00	38.88	64.71
CVA				27.78	22.22	17.65
Others				5.56	0.0	0.0
Status (% Out)				94.44	100	94.12

Note: Education = years of education; Gender = percentage of female participants; matrix = score on the matrix subtest of the WAIS-IV; D2 = score on the D2 test; WMS-IV = score on the word paired associates subtest of the WMS-IV; TSI = time since injury; TBI = percentage of people who had sustained a traumatic brain injury; Mild = percentage of people who had sustained a mild traumatic brain injury; moderate = percentage of people who had sustained a moderate traumatic brain injury; severe = percentage of people who had sustained a severe brain injury; CVA = percentage of people who had sustained a cerebrovascular accident; Status = percentage of outpatients.
*$p < .001$.

Symmetrically (examining the effect of group in each condition), the interaction between d1 and group revealed a significant effect of group in the stereotype lift condition ($b = -.33$, $SE = .13$, $t = -2.62$, $p = .010$, 95% CI = [−.58, −.08]), indicating that in this condition participants with ABI scored significantly lower than control participants (as in the DT condition); but no effect of group in the neutral-cognitive condition ($p = .307$), showing that in this condition participants with ABI scored as well as control participants.

Memory score. There was a significant effect of group (in the DT condition) ($b = -.37$, $SE = .11$, $t = -3.31$, $p = .001$, 95% CI = [−.60, −.15]) and d1 ($b = .36$, $SE = .16$, $t = 2.24$, $p = .028$, 95% CI = [.04, .68]). While the interaction between group and d1 was non-significant ($b = .15$, $SE = .16$, $t = .94$, $p = .352$, 95% CI = [−.15, .50]), we probed this interaction due to our specific hypothesis that neutral-cognitive instructions would lead to better performance in participants with ABI. Specific contrasts showed that participants with ABI did indeed perform better following neutral-cognitive instructions than participants receiving DT instructions ($b = .51$, $SE = .23$, $t = 2.24$, $p = .027$, 95% CI = [.06, .96]). There was no effect of instructions (d1) for control participants ($p = .360$) (see Fig. 1). There was no effect of d2 ($p = .281$) or significant interaction between group and d2 ($p = .875$) on performance. Using d2, no specific contrast was significant (ps > .382).

Further examination of the interaction between d1 and group revealed a negative impact of group in both the stereotype lift ($b = -.35$, $SE = .12$, $t = -3.00$, $p = .003$, 95% CI = [−.58, −.12]) and cognitive-neutral ($b = -.23$, $SE = .11$, $t = -1.99$, $p = .049$, 95% CI = [−.45, −.00]) conditions.

Processing speed score. There was an effect of group ($b = -.49$, $SE = .12$, $t = -4.01$, $p < .000$, 95% CI = [.25, .74]), but no effect of d1 ($p = .147$) or d2 ($p = .232$), nor was there an interaction between group and d1 ($p = .388$) or between group and d2 ($p = .478$). No specific contrast was significant (ps > .103).

Mediation Analyses

The analyses described above showed that, in participants with ABI only (not in the control group), DT had a deleterious impact on memory and executive performance compared to the neutral-cognitive instructions. We then conducted further analyses to examine the mediating mechanisms responsible for these effects on the ABI group only. First, we tested the impact of condition on the mediators (set as dependent variables) by conducting the same analyses as above, but only in the ABI group.

For negative emotions, there was an effect of d1 ($b = -.33$, $SE = .16$, $t = -2.04$, $p = .046$, 95% CI = [−.65, −.01]), indicating that participants with ABI in the DT condition reported more negative emotions than such participants in the neutral-cognitive condition, but no effect of d2 ($p = .986$) (Note that, due to one missing data point for negative emotions, these analyses were conducted on 52 participants.). For task expectancy, the results showed an effect of d1 ($b = .92$, $SE = .28$, $t = 3.31$, $p = .002$, 95% CI = [.36, 1.47]) revealing that participants with ABI in the DT condition had lower task expectations than participants with ABI in the cognitive neutral condition, but no effect of d2 ($p = .907$) (see Fig. 2). Regarding task-related interference, there was no

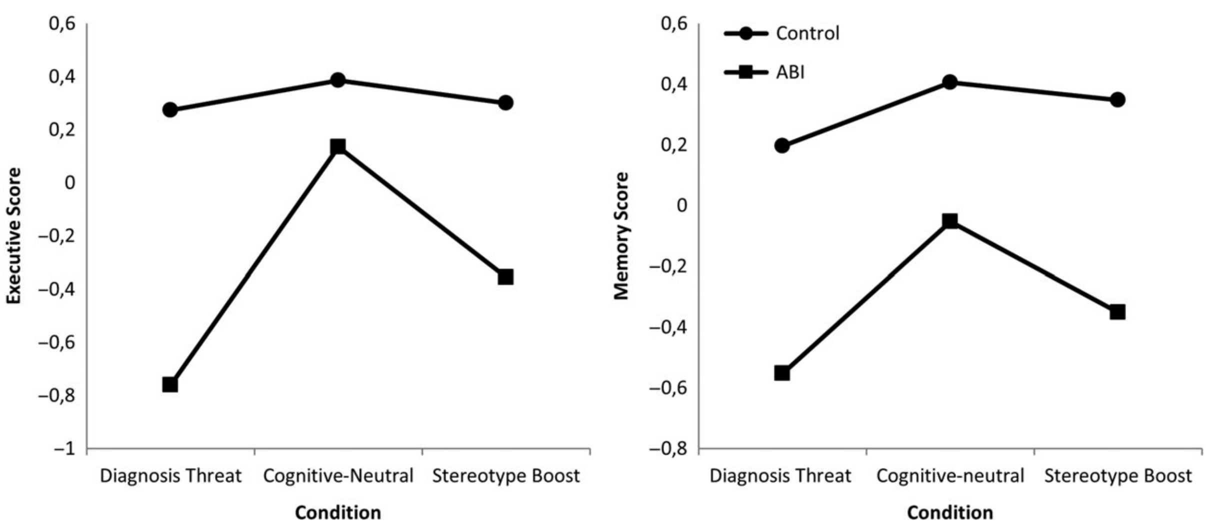

Fig. 1. Effect of condition on the executive and memory performance of control participants and participants with acquired brain injury. *Note*. Results of regression-based analyses using dummy coding for multicategorical independent variables with diagnosis threat as the reference group ($N = 106$).

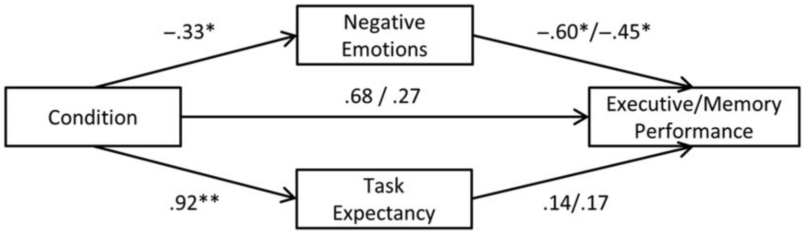

Fig. 2. Mediation analyses testing for the indirect effect of experimental condition (diagnosis threat condition = 0, cognitive-neutral condition = 1) on memory and executive performance. *Note*. Values represent conditional coefficients. Values to the left of the slash relate to executive functioning as dependent variable while values to the right of the slash concern memory performance ($N = 52$). $^*p < .05$; $^{**}p < .01$.

effect of d1 ($p = .672$), but there was an effect of d2 ($b = .42$, $SE = .17$, $t = 2.46$, $p = .017$), indicating that participants with ABI in the stereotype lift condition had more intrusive thoughts than in the DT condition. There was no effect of d1 or d2 on self-efficacy ($ps > .289$).

In sum, we showed that, compared to the DT condition, participants with ABI in the cognitive-neutral condition obtained better memory and executive scores; as well, they reported higher task expectations and fewer negative emotions. Consequently, we examined whether the deleterious effect of DT (compared to cognitive-neutral instructions) on executive and memory performance was mediated by task expectancy and negative emotions. We ran two regression-based path analyses (one for each cognitive score) to test for mediation, following the approach proposed by Hayes (2013) and Hayes and Preacher (2014), using the Process computational tool (Hayes, 2013). For each cognitive score (executive and memory), performance was predicted by both dummy codes and the two mediators were mean-centered. We then directly examined the indirect effect of d1 on the executive and memory scores of participants with ABI through task expectancy and negative emotions with bias-corrected 10,000 resample bootstrap confidence intervals. If zero is outside the bootstrap confidence intervals, there is a significant indirect effect at the significant level of $p \leq .05$ (mediating effect).

Executive score. As shown in Fig. 2, negative emotions had a significant effect on executive score ($b = -.60$, $SE = .27$, $t = -2.25$, $p = .029$, 95% CI = [−1.14, −.06]), with higher levels of negative emotions being linked to poorer executive performance. There was, however, no significant effect of task expectancy on the executive score ($p = .379$). Finally, there was no effect of d2 ($p = .190$). The bias-corrected 10,000 resample bootstrap confidence interval for the mediation through negative emotion was entirely above zero ($b = .20$, SE = .17, 95% CIs [.00, .77]), indicating mediation by negative emotions. Analyses of bias-corrected bootstrap confidence intervals for task expectancy showed no evidence of mediation ($b = .13$, SE = .14, 95% CIs [−.09, .50]). The effect of contrast 1 was marginally significant ($b = .68$, $SE = .34$, $t = 1.98$, $p = .054$, 95% CI = [−.01, 1.38]), which suggested partial mediation by negative emotions.

Memory score. Negative emotions had a significant effect on memory score ($b = -.45$, $SE = .20$, $t = -2.18$, $p = .034$, 95% CI = [−.86, −.03]), with higher negative emotions being associated with poorer memory performance. There was no effect of task expectancy ($b = .17$, $SE = .12$, $t = 1.40$, $p = .167$, 95% CI = [−.07, .41]) on memory score. Examining indirect effects, the bias-corrected bootstrap confidence interval for negative emotions was entirely above zero ($b = .15$, SE = .09, 95% CIs [.03, .44]), providing evidence for mediation by negative emotions. This was not the case for the indirect effect of DT through task expectancy ($b = .15$, SE = .13, 95% CIs [−.08, .43]). There was no effect of d1 ($b = .27$, $SE = .26$, $t = 1.03$, $p = .307$, 95% CI = [−.26, .81]) on memory score, indicating full mediation by negative emotions (see Fig. 2).

Discussion

Our study was designed to further examine the impact of the diagnosis threat phenomenon (Suhr & Gunstad, 2002, 2005) on people with ABI. As expected, our results showed that the cognitive performance of control participants (with no history of neurological accident) was not impacted by instructions. Conversely, participants with ABI scored significantly lower on executive and memory (but not processing speed) tasks in the DT condition compared to participants with ABI in the neutral-cognitive condition. Moreover, these effects were mediated by negative emotions: DT instructions elicited more negative emotions, which in turn led to poorer performance. Although the DT instructions led to lower task expectancy than the cognitive-neutral instructions, there was no evidence of mediation by task expectancy (nor by intrusive thoughts and self-efficacy). Finally, stereotype lift instructions had no impact on the cognitive performance of participants with ABI (compared to the DT instructions). These results are discussed below.

As expected, the performance of neurologically normal participants was not affected by instructions. This is presumably because they did not feel concerned by the activated stereotype. As such, they performed equally well in all conditions. Conversely, our results showed that participants with ABI performed worse in the DT than in the cognitive-neutral condition: compared to the DT instructions, in which their neurological status and their cognitive difficulties were emphasized, instructions that deemphasized the diagnosticity of the upcoming tasks and did not highlight their neurological problem led participants with ABI to outperform. These results are in accordance with those of Kit et al. (2014), who showed that compared to a heightened threat condition, their participants with mild or moderate TBI performed better cognitively when the threat cues were reduced. In their study, they manipulated not only stereotypes but also feelings of control over cognitive problems, which made it impossible draw conclusions on the specific impact of DT. Our results support their findings, showing that DT can exacerbate the cognitive difficulties of participants with ABI.

It is important to emphasize that our DT instructions were quite similar to the instructions usually given to neurological patients in a clinical setting. Indeed, individuals with ABI who are about to undertake a cognitive assessment are reminded of their cognitive status and their cognitive difficulties during the case history. As well, they are generally told that their cognitive performance will be compared to normative data. Clinical neuropsychologists should be aware of the potential detrimental impact of DT when they conduct neuropsychological assessments of people with ABI, given that DT has been proposed to lead to poorer clinical outcomes. For example, in the study by Kit et al. (2014), participants with ABI in the heightened threat condition obtained more clinically impaired performance (performance at 1.5 *SD* below the normative mean) than participants in the reduced threat condition, showing that DT can lead to biased task results in clinical settings (i.e., overdiagnosis of cognitive deficits). Since, for methodological reasons, we did not administer clinical cognitive tasks, we cannot compare the participants' performance to normative means. Nonetheless, it is noteworthy that, compared to the neutral-cognitive condition, DT led to poorer memory and executive performance. More interestingly, in the neutral-cognitive condition, participants with ABI did not differ from control participants on their executive scores (no effect of group in this condition), whereas they obtained poorer executive scores than control participants in the other two conditions. Our claim is not that DT accounts fully for the cognitive difficulties of participants with ABI; besides, participants with ABI still have worse memory performance than control participants under cognitive-neutral instructions. Instead, we propose that if the clinical setting activates some form of DT (notably through the case history), this can sometimes exacerbate the cognitive difficulties of participants with ABI in the following assessment.

Although we observed an impact of DT (compared to the cognitive-neutral condition) on memory and executive performance, this was not the case for attention tasks. According to Schmader et al. (2008), stereotype threat triggers a set of intrusive thoughts and negative emotions that individuals try to suppress. These suppression processes (emotional regulation) rely heavily on working memory and executive resources (Schuster, Martiny, & Schmader, 2015). Consequently, performance of tasks that rely heavily on executive functioning are especially susceptible to stereotype threat since these capacities are no longer available for task completion. In our study, the memory tasks assessed the learning of visual and auditory material that went beyond the normal span, and then required executive processes to engage in strategic encoding of information. As well, the executive tasks we selected tapped the following dimensions of executive functioning: inhibition, flexibility, and working memory updating. On the other hand, the processing speed tasks assessed simple target detection capacities, with minimal recruitment of inhibition, working memory, or flexibility. Since they relied less on executive functioning, they may have been less affected by DT. Then, while studies showed that speed of processing is affected by ABI (Mathias & Wheaton, 2007), present findings would suggest that speed of processing is not affected by diagnosis threat.

Relatedly, our results showed that the deleterious impact of DT on memory and executive performance was mediated by negative emotions. The DT instructions elicited more negative emotions than the neutral-cognitive condition. In turn, these negative emotions had a negative impact on memory and executive performance. These results are in accordance with Schmader et al. (2008) hypothesis that stereotype threat targets negative emotions that occupy working memory (and executive) capacities, which are no longer available for task completion. For example, Keller and Dauenheimer (2003) showed that activation of the negative stereotype about girls' math performance led their female participants to get worse scores; their results indicated that the feeling of dejection mediated this harmful effect. That is to say, the stereotype threat elicited feelings of dejection, which in turn depleted performance. Our study is the first to show the mediating role of negative emotions in DT. Past studies have examined the role of anxiety by administering general measures of anxiety such as the State-Trait Anxiety Inventory (Spielberger, Gorsuch, & Lushene, 1983), but found no evidence of mediation by anxiety (Kit et al., 2014; Ozen & Fernandes, 2011; Suhr & Gunstad, 2005). In this study, we administered a measure of mood state encompassing dimensions of energetic arousal (e.g., "unenterprising"), tense arousal (e.g., "nervous"), hedonic tone (e.g., "dissatisfied"), and anger/frustration (e.g., "irritated"). This kind of measure could be more suitable to capture the complex interplay of negative emotions that results from DT than an anxiety measure alone.

Although DT led to lower task expectations than the cognitive-neutral condition (Cadinu et al., 2003; Desrichard & Kopetz, 2005), task expectancy did not explain the negative impact of DT on memory and executive performance. This could be due to the measure we used – a single item scale – which could be less adequate to detect mediation. As well, another mediator not measured in our study could act jointly with task expectancy to impair performance. Contrary to Kit et al. (2014), we did not observe

DT to negatively affect self-efficacy. This could be explained by stereotype activation differences. Different threats have been proposed to induce different emotional and cognitive consequences (Shapiro & Neuberg, 2007). Our neutral-cognitive instructions aimed at deemphasizing the cognitive nature of the tasks, as well as the participants' cognitive status. On the contrary, the reduced-threat instructions of Kit et al. (2014) claimed that participants with TBI recover fully with time and that they can manage their problems (with effort) and overcome their deficits. Unlike our instructions, their specific instructions may have specifically targeted self-efficacy feelings. Finally, there was no evidence of mediation of DT impact (compared to cognitive-neutral instructions) by intrusive thoughts. It could be that our measure of intrusive thoughts was not specific enough. The items relate to a lot of different thought content (e.g., family members, time elapsed, etc.). Moreover, this measure does not include the emotional valence of thoughts (participants may report having thought a lot about their performance, but this could be either a positive or a negative thought). This point should be further explored in future studies, which should administer scales of specific negative and positive thoughts relating to the tasks, competence, etc. (Cadinu, Maass, Rosabianca, & Kiesner, 2005).

Finally, compared to the DT condition, we did not observe an impact of our stereotype lift instructions on cognitive performance. We simply observed that stereotype lift instructions led to more intrusive thoughts for participants with ABI. There may be several reasons for this finding. First, even though we specified in the stereotype lift condition that medical files indicated no risk of developing Alzheimer's disease, the stereotype lift instructions could still have stressed participants with ABI. They may have feared that their results would indicate that they were developing Alzheimer's disease, especially if they were previously informed that a history of traumatic brain injury leads in certain circumstances to an exacerbated cognitive decline. If they felt anxious and concerned about their risk of developing Alzheimer's disease, this could explain why the stereotype lift instructions led to more intrusive thoughts. Second, stereotype lift is proposed to be based on downward comparison (Shih et al., 2012): individuals need to perceive competence differences between the in-group and the out-group. It is possible that, in the mind of the general public, the social group of people with ABI is too closely associated with Alzheimer's disease, preventing them from making a downward comparison. Third and relatedly, our participants were relatively low-educated (more than half of them stopped their education after high school). Consequently, they may have had less knowledge about Alzheimer's disease (e.g., thinking that people with ABI develop Alzheimer's disease, thinking that its symptoms are equal to those of ABI, etc.), which prevented them from making a downward comparison.

There are some limitations on the present study. First, the neuropsychological tasks were administered to all participants in the same order. Thus, there could be a task order effect contributing to our results. Future studies should counterbalance tasks order to control for possible order effects. As well, the participants with ABI were people with TBI, cerebrovascular accidents, and other neurological conditions. Statistical analyses revealed no difference between conditions regarding important ABI-related characteristics (e.g., time elapsed since injury, type of injury, baseline cognitive task performance, etc.). Future studies should nonetheless consider the effect of DT in each kind of neurological condition. There could be some specificity of stereotypes regarding different neurological conditions. Relatedly, no study has yet examined the influence of DT on the cognitive performance of people with degenerative neurological conditions. There is reason to think that DT could be particularly pervasive in such conditions (Scholl & Sabat, 2008). Third, the tasks we administered were either experimental or adapted from existing clinical tasks. As a consequence, one can question the cognitive construct they are supposed to measure. As well, clinically-valid tasks with normative data would have been informative regarding the clinical impact of diagnosis threat (for example, does diagnosis threat lead to an increase of performance below the pathological threshold?). This limitation should be taken into account in future studies. Finally, we chose to exclude people with ongoing psychiatric condition. If this avoid a possible confounding effect of psychiatric conditions, it diminishes the representativeness of our sample. Psychiatric conditions, like anxiety disorders or depression, could influence (moderate) the impact of diagnosis threat (for example, people with depression could be especially impacted by diagnosis threat). As such, future studies should take into account the influence of psychiatric condition in diagnosis threat studies.

Conclusion

Our study showed that compared to a condition in which the participant's cognitive status and the cognitive components of tasks were deemphasized, participants with ABI underperformed on memory and executive tasks following DT instructions. This study showed the necessity for clinicians to consider the influence of harmful stereotype effects when they conduct neuropsychological assessments with people with ABI. Our results indicate that DT can exacerbate the cognitive deficits of people with ABI, possibly leading in some cases to inaccurate diagnosis of cognitive deficits. The influence of stereotypes should also be taken into account regarding the clinical history of people with ABI outside the influence of diagnosis threat instructions. Following an ABI, people could face discouraging information regarding their recovery and associated long-term sequelae. These internalized negative stereotypes could constitute fertile ground for the effect of stereotype threat (see for example, Rao et al., 2009). Future studies should then consider the influence of self-stigma in the neuropsychological assessment of people with ABI.

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Conflict of interest

We have no conflicts of interest to declare

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Appendix 1

Note that for diagnosis threat and stereotype lift instructions, the text in brackets to the left of the slash was the version of the instructions destined for participants with ABI and the text to the right was for control participants.

Diagnosis Threat Condition:

You have been invited to participate in this study because you [have suffered/have not suffered] from an acute neurological event (for example, a traumatic brain injury, a cerebrovascular accident, etc.).

A growing number of scientific studies show that acute neurological events trigger several deficits on neuropsychological tests. In particular, these difficulties (deficits) relate to concentration, memory, and reaction speed. Thus, people who have suffered from an acute neurological event have many more cognitive difficulties than people who have never suffered from such an event.

The goal of our research is to study the impact of neurological events on memory and concentration problems. To do so, we will compare your results to the results of people [who did not have/who had] a neurological problem.

A technician will now come and ask you to complete a set of neuropsychological tests. These tests assess competences such as concentration, memory, and reaction time. Some of these tests are easy, while others are more difficult. Please make your best effort. I will answer your questions about the different tests at the end of the test session.

Cognitive-Neutral Condition

You have been invited to participate in this study because you don't have hearing or vision problems (for example, a cataract, deafness, etc.).

A growing number of scientific studies show that hearing and vision trigger several processes involved in visual and auditory tests. In particular, these processes (mechanisms) relate to color perception and sound discrimination. Thus, capacities for vision and hearing comprises many more sensory processes than people imagine.

The goal of our research is to study the impact of these different processes on visual and auditory detection capacities.

A technician will now come and ask you to complete a set of visual and auditory tests. These tests assess competences such as color and shape perception, and auditory discrimination. Some of these tests are easy, while others are more difficult. Please make your best effort. I will answer your questions about the different tests at the end of the test session.

Stereotype Lift Condition

You have been invited to participate in this study because you [have suffered from an acute neurological event (for example, a traumatic brain injury, a cerebrovascular accident…) and your medical dossier indicates that you don't have or aren't at risk of getting Alzheimer's disease/don't have Alzheimer's disease].

A growing number of scientific studies show that Alzheimer's disease triggers the most severe deficits on neuropsychological tests. In particular, these difficulties (deficits) relate to concentration, memory, and reaction speed. Thus, people who have Alzheimer's disease have many more cognitive difficulties than people who [have suffered from an acute neurological event (traumatic brain injury, cerebrovascular accident, etc.)/don't have Alzheimer's disease].

The goal of our research is to study the most severe impacts of Alzheimer's disease on memory and concentration problems. To do so, we will compare your results to the results of people who have Alzheimer's disease.

A technician will now come and ask you to complete a set of neuropsychological tests. These tests assess competences such as concentration, memory, and reaction time. Some of these tests are easy, while others are more difficult. Please make your best effort. I will answer your questions about the different tests at the end of the test session.