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Influence of diagnosis threat and illness cognitions on the cognitive performance of people with acquired brain injury

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ABSTRACT
Illness cognitions – cognitive representations of illness – have been found to influence health outcomes in chronic diseases: more adaptive illness cognitions generally lead to better outcomes. Concomitantly, diagnosis threat (DT) is a phenomenon whereby participants with acquired brain injury (ABI) underperform on neuropsychological tasks due to stereotype activation. This randomised study examined the impact of illness cognitions and DT on cognitive performance. People with ABI completed the Illness Cognitions Questionnaire and were then exposed to either a DT condition or a reduced DT condition (in which stereotype cues were reduced). They then completed memory and attentional tasks. Control participants performed only the tasks under one of the two conditions. Under the reduced DT condition, higher adaptive illness cognitions were associated with better memory and attentional performance. However, the DT condition diminished memory (but not attentional) performance in participants with a high level of adaptive illness cognitions, often leading to performance at the pathological level. This study confirms the detrimental impact of DT in people with ABI and highlights the necessity for clinicians to consider psychosocial influences when assessing and treating this population.

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Introduction

Following an acquired brain injury (ABI; e.g., traumatic brain injury, stroke, etc.), people can suffer from physical, cognitive, and emotional disorders. These disabilities may then considerably impede patients' community participation (Doig, Fleming, & Tooth, 2001; Van Velzen, Van Bennekom, Edelaar, Sluiter, & Frings-Dresen, 2009). How people feel about and adapt to chronic disabilities is a topic that has been studied in relation to ABI. Brands, Wade, Stapert, and van Heugten (2012) proposed that, following a brain injury, the process of adaptation is "characterized by a continuous and complex interaction between two processes: achieving maximal restoration of function and adjusting to the alterations and losses that occur in the various domains of physical and psychosocial functioning" (p. 841). Evers et al. (2001) identified three

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kinds of illness cognitions – ways in which people react to and evaluate their illness – which can facilitate or impede the adaptation process. The first one is *helplessness*: these cognitions focus on the negative consequences of disabilities. Successive experiences of failures in the adaptation process can in fact progressively lead to a state of learned helplessness in people with ABI (Yates, 2003). The second illness cognition is *acceptance*, which is triggered by successful adjustment and attainment of goals that lead to positive emotions (Ben-Yishay, 2000; Brands et al., 2012). People gradually accept the negative consequences of their ABI and learn to manage them. Finally, the third cognition, called *perceived benefits*, refers to the perceived positive consequences of the ABI. It is linked to the phenomenon of post-traumatic growth, which has been studied in people with brain injury. Powell, Ekin-Wood, and Collin (2007) showed that, over time, people with ABI report positive changes in areas such as relationships and appreciation of life. These cognitions are not dichotomous and the degree to which people hold each one varies.

Illness cognitions have been studied in a wide range of patients with chronic disabilities, including cancer (Bossema et al., 2011), chronic pain (Viane, Crombez, Eccleston, Devulder, & De Corte, 2004), and multiple sclerosis (Van der Werf, Evers, Jongen, & Bleijenberg, 2003). Overall, these studies showed that a high level of acceptance and/or perceived benefits is linked to a better quality of life, fewer undesirable symptoms, better emotional status, etc. As such, acceptance and perceived benefits cognitions about chronic disabilities are considered to be adaptive illness cognitions. Conversely, since helplessness is generally associated with poor outcomes, this type of illness cognition is considered non-adaptive. Studies conducted with people with ABI found similar results. For example, Van Mierlo, van Heugten, Post, de Kort, and Visser-Meily (2015a) showed that a low level of helplessness and a high level of acceptance and perceived benefits two months after a stroke predicted better life satisfaction two years after the stroke. In people with ABI, Whiting, Deane, Ciarrochi, McLeod, and Simpson (2015) showed that greater acceptance of the brain injury and its consequences were associated with a more positive affect. Townend, Tinson, Kwan, and Sharpe (2010) showed that a lower level of acceptance one month after a stroke predicted depression nine months after the stroke (see also Kootker et al., 2016; Van Mierlo, Van Heugten, Post, De Kort, & Visser-Meily, 2015b). In general, studies conducted in people with ABI revealed that, unlike helplessness, acceptance and perceived benefits are adaptive illness cognitions that protect patients against the negative effects of brain injury on well-being and quality of life. In fact, some cognitive behavioural therapies conducted with neurological patients target acceptance and helplessness with the aim of increasing the former and decreasing the latter (Joosten-Weyn Banningh, Kessels, Rikkert, Geleijns-Lanting, & Kraaimaat, 2008). However, to our knowledge, no study has yet examined the influence of illness cognitions on cognitive performance. Based on the literature reviewed, we predict that a higher level of adaptive illness cognitions should lead to better performance in cognitive assessments.

Although the impact of illness cognitions on neurological patients' cognitive performance has not been examined, there is now some empirical evidence that contextual and social factors can also influence the cognitive performance of people who have experienced a neurological condition. In this regard, stereotypes – a set of shared beliefs regarding the characteristics of a particular group – have been found to impede the performance of several different stereotyped groups in a variety of domains (e.g., mathematics, memory, etc.). Stereotype threat refers to a phenomenon whereby a stigmatised group's performance decreases in a particular domain when participants are reminded of their alleged inferiority in this domain (Steele & Aronson, 1995). For example, in the literature on ageing, older persons have been found to underperform on memory or cognitive tasks when the memory components of the task or age-related cognitive decline were highlighted (Desrichard & Kopetz, 2005; Hess, Auman, Colcombe, & Rahhal, 2003). This phenomenon can even led to pathological performance, that is, task results significantly below the pathological threshold according to normative data (Haslam et al., 2012).

Suhr and Gunstad (2002, 2005) showed that, when reminded about their mild traumatic brain injury (mTBI), undergraduate students underperformed on several neuropsychological tasks compared to counterparts who were not reminded of their neurological history. The authors called this phenomenon "diagnosis threat". Since then, some studies have shown the negative impact of diagnosis threat on neuropsychological performance (Pavawalla, Salazar, Cimino, Belanger, & Vanderploeg, 2013), cognitive complaints (Ozen & Fernandes, 2011), and self-efficacy (Trontel, Hall, Ashendorf, & O'Connor, 2013). It is worth noting that these studies were conducted with undergraduate students who reported having sustained an mTBI in their past – sometimes more than 10 years ago. Thus, diagnosis threat can negatively impact the cognitive performance and subjective assessment of high-functioning students in whom there is no reason to expect feelings of cognitive "inferiority". In other words, simply reminding high-functioning students about their past history of mTBI can lead them to underperform. People who have benefited from cognitive rehabilitation following an ABI (and resulting cognitive impairments) may be especially vulnerable to diagnosis threat. Whether people suffering from ABI – a "true" clinical population – also underperform following diagnosis threat is obviously an important question. Our general hypothesis is therefore that the cognitive performance benefits of adaptive illness cognitions will disappear under diagnosis threat instructions compared to a condition with no or reduced threat.

To our knowledge, only one study has investigated the phenomenon of diagnosis threat within a "clinical" population. Kit, Mateer, Tuokko, and Spencer-Rodgers (2014) recruited participants who had previously suffered from a mild to moderate traumatic brain injury (TBI). Before completing neuropsychological tasks, participants were exposed to either a diagnosis threat condition or a reduced threat condition. In the reduced threat condition, stereotype cues were minimised and instructions emphasised the controllability of cognitive capacities. The results showed that participants in the diagnosis threat condition performed worse on attention and memory encoding tasks than their counterparts in the reduced threat condition. Moreover, this effect was mediated by memory self-efficacy. This is an important result, as higher self-efficacy has been shown to lead to better life satisfaction and adjustment after ABI (Brands, Köhler, Stapert, Wade, & van Heugten, 2014; Cicerone & Azulay, 2007) and to better cognitive capacities (Aben et al., 2009). Moreover, the deleterious impact of diagnosis threat through self-efficacy was powerful enough to lead to more pathological performance, that is, performance significantly below the clinical (pathological) threshold (see also Suhr & Gunstad, 2002, 2005).

The purpose of this study was to investigate the impact of diagnosis threat on the cognitive performance of people with ABI. First, for control participants, for whom the stereotype is simply irrelevant, diagnosis threat should have no effect (Hypothesis 1). In light of the literature reviewed above, for the neuropsychological participants under optimal conditions (reduced threat condition in which diagnosis threat cues were eliminated), the more adaptive illness cognitions participants reported, the better they should perform (Hypothesis 2a). For neuropsychological participants confronted by a diagnosis threat, the beneficial effect of adaptive illness cognitions should disappear. As a result, the performance of participants with a high level of adaptive illness cognitions should be lower than that of the same participants in the reduced threat condition (Hypothesis 2b). Finally, we also tested whether the detrimental effect of diagnosis threat for participants with ABI would lead them to perform below the clinical threshold more often than participants in the reduced threat condition (Hypothesis 3).

Method

Participants

The people with ABI were recruited in cognitive rehabilitation centres in Belgium. Some of the patients were still receiving cognitive rehabilitation and others were not. We recruited 38 participants who had sustained an acute (as opposed to degenerative) neurological disorder: 26 persons who had sustained a (mild to severe) TBI, 10 persons who had sustained a cerebrovascular accident, one person who had suffered from encephalitis, and one who had sustained a brain tumour. For various reasons, two participants could not take part in the entire testing session. Due to their numerous missing data, these two participants were excluded from the analyses, leading to a sample of 36 participants with ABI. We also recruited 38 healthy control participants matched with the participants with ABI for age and years of education. Participants' (control and ABI) ages ranged from 17 to 64 years. There were 18 participants with ABI and 19 control participants in each experimental condition (diagnosis threat and reduced threat).

Regarding inclusion/exclusion criteria for patients with ABI, because we wanted to study the impact of diagnosis threat on patients for whom neurological identity was relevant, all of them had to be receiving or have received a cognitive rehabilitation programme to treat their cognitive disorders. As well, participants with ABI had to have sustained their neurological accident within the past 5 years. To avoid the acute effects of neurological disorder, participants with ABI who were still undergoing rehabilitation could not be in-patients. As well, all participants (control and ABI) had normal or corrected hearing and vision, and no neurological visual or auditory disorders (e.g., hemianopia, unilateral neglect, etc.). Finally, both control participants and participants with ABI could not have significant hand motion problems (so they could complete the neuropsychological tasks).

Material

Baseline measures. To ensure equivalence between groups regarding premorbid intelligence and emotional states, we administered the French version of the National Adult Reading Test (FNART; Blair & Spreen, 1989), the Beck Depression Inventory – second edition (BDI-II; Beck, Steer, & Brown, 1996), the trait form of the State Trait Anxiety Inventory (STAI-YB; Spielberger, Gorsuch, & Lushene, 1983), and the Hopelessness scale (Beck & Steer, 1988).

FNART (Blair & Spreen, 1989). In this test that assesses premorbid intelligence level, participants have to read aloud 34 words with irregular spelling. The total number of correct responses was recorded.

BDI-II (Beck et al., 1996). This inventory assesses depression symptoms on a 21-item scale (Cronbach's alpha = .90). For each item, participants choose from among four responses indicating increasing depression severity. A higher score indicates a higher level of depression.

STAI-YB (Spielberger et al., 1983). The STAI-YB assesses trait anxiety (in opposition to state anxiety) (Cronbach's alpha = .93). Participants respond to 20 items using a 4-point Likert scale (from "no" to "yes"). A higher score indicates a higher level of anxiety.

Hopelessness scale (Beck & Steer, 1988). This 20-item true-false questionnaire assesses feelings of hopelessness. A higher score represents a stronger feeling of hopelessness.

Neuropsychological tasks. Participants were given a set of neuropsychological tests that are generally used for the clinical assessment of patients who have sustained an acute neurological disorder. These tasks assess memory and attentional functions.

Memory tasks

California Verbal Learning Test (*CVLT;* Delis, Kramer, Kaplan, & Ober, 1987). During the learning phase of this episodic memory task, a list of 16 words (four semantic categories) is read aloud to participants five times. Each time, participants have to recall as many words as they can. After a 20-minute delay, participants are given free and cued (with the four semantic categories as cues) recall tasks. The total numbers of words produced during the learning phase and during the recall phase were recorded.

The working memory subtask of the Test of Attentional Performance (*TAP;* Zimmermann & Fimm, 2010). During this n-back task, digits from 1 to 9 appear sequentially on the screen. Participants are required to press the response button each time the digit they see is identical to the second last one. The number of omissions (failure to detect targets) was recorded.

The Brown-Peterson Task (Geurten, Vincent, Van der Linden, Coyette, & Meulemans, 2016). In this task, participants have to memorise consonant trigrams that are displayed on the computer screen. Immediately afterward or after a delay of 5, 10 or 20 seconds, participants have to recall the trigram. During the delay, participants complete an interfering task: repeating digit pairs in the opposite order (e.g., 3–6 in response to 6–3). The percentage of correct consonants was recorded.

Attentional tasks

The divided attention subtask of the TAP (Zimmermann & Fimm, 2010). During this attentional task, participants have to monitor visual (a pattern of moving crosses) and auditory (an alternation between low and high sounds) stimuli. Participants have to press the response button as quickly as possible when there is either a pattern of four crosses forming a square or a break in the alternation of sounds. The median Response Time (RT) was recorded.

The incompatibility subtask of the TAP (Zimmermann & Fimm, 2010). Arrows pointing either left or right appear sequentially on either the left or right side of the screen. Participants have to press the (left or right) response button corresponding to the direction of the arrow as quickly as possible. The median RT was recorded.

The flexibility subtask of the TAP (Zimmermann & Fimm, 2010). In this computerised task, participants have to alternate between two kinds of stimuli (letters and numbers). A letter/number pair appears sequentially on the screen. For each item, participants have to respond as quickly as possible by pressing the response button (left or right) corresponding to the location of the letter, then the location of the digit, and so on. We recorded the median RT.

The Stroop task (Godefroy & GREFEX, 2008; Stroop, 1935). During this well-known task, participants have to name as quickly as possible the colour in which a colour name is printed (e.g., *blue* printed in red). The completion time was recorded.

Data reduction. To reduce the number of dependent variables and thus avoid type I errors, we calculated z-scores for each task score and averaged them to create composite scores, one related to memory functioning, and the other to attentional functioning. The memory score was created by averaging the z-scores of the percentage of correct consonants in the Brown-Peterson task (Geurten et al., 2016), the number of omissions (reversed) during the working memory subtest of the TAP (Zimmermann & Fimm, 2010), the total number of correctly recalled words produced during the encoding phase of the CVLT (Delis et al., 1987), and the total number of correctly recalled words during the recall phase of the CVLT. These memory task scores were all correlated ($rs > .36$, $ps < .000$). We created an attentional score by averaging reversed z-scores for the mean RTs for the flexibility, incompatibility and divided attention subtests of the TAP (Zimmermann & Fimm, 2010), and the completion time for the Stroop task (Godefroy & GREFEX, 2008). These attentional task scores were all correlated ($rs > .38$, $ps < .000$). For both composite scores, higher values represent better performance.

Additional measures. Because we were interested in the moderating role of illness cognitions, we administered the Illness Cognitions Questionnaire (ICQ; Evers et al., 2001) to participants with ABI before stereotype activation.[1]

ICQ (Evers et al., 2001). This scale is composed of 18 items and encompasses the three dimensions of representations that individuals can hold about their illness: helplessness (six items), acceptance (six items), and perceived benefits (six items). Participants respond using a 4-point Likert scale ranging from "not at all" to "completely". We created an index of adaptive illness cognitions by averaging responses for all items (with the helplessness items being reversed). A higher score represents a higher level of adaptive cognitions (Cronbach's alpha = .94).

Manipulation check questionnaire. The manipulation check measure comprised two extracts from the reduced threat instructions and two extracts from the diagnosis threat instructions. For each true-false item, participants had to respond in accordance with the experimental instructions they received.

Procedure

This study was approved by the Ethics committee of the psychology department (University of Liège), the Ethics committee of the university-affiliated hospital of Liege (as the central medical Ethics committee for this study), as well as by the Ethics committees of each (peripheral) participating hospitals (reference number 2013-188). Participants were invited to participate in a study about (cognitive) outcomes following brain injuries. Participants were told that they are free to participate or not, as well as free to terminate their participation whenever they wanted to without any justification. They were told that if they agree to participate, they will undergo a neuropsychological assessment. All participants provided their written informed consent to participate in this study.

Prior to the neuropsychological assessment, participants were asked to complete the STAI-YB (Spielberger et al., 1983), the BDI-II (Beck et al., 1996), the hopelessness scale (Beck & Steer, 1988), and the ICQ (Evers et al., 2001), with the last one administered only to the ABI group. During the neuropsychological assessment, they first completed the FNART (Blair & Spreen, 1989). Then, they watched a video tape (using earphones) that corresponded to the experimental condition to which they had been randomly assigned. Doing this, the experimenter remained blind to the experimental condition. Note that we tried to match the control participants for age and educational level (and, when possible, gender). As such, each control participant was assigned to the same experimental condition as the corresponding participant with ABI. The experimental instructions were adapted from those of Kit et al. (2014). Participants in the reduced diagnosis threat condition (versus the *diagnosis threat* condition) heard that

> people who have sustained a neurological disorder, such as a TBI or a cerebrovascular accident, usually (*do not*) recover fully (*even*) after a period of time … Scientific research also shows that everyone (*no one*) can control or have an influence on his/her memory and concentration … People who see a neuropsychologist for a rehabilitation/therapy (*do not*) improve quickly … (see Appendix).

To ensure that participants understood and paid attention to the experimental instructions, they were asked to respond to four true-false questions related to the video they had just watched. Then, participants completed neuropsychological tasks in the following order (or in the opposite order): the Brown-Peterson task (Geurten et al., 2016), the encoding phase of the CVLT (Delis et al., 1987), the working memory subtest of the TAP (Zimmermann & Fimm, 2010), the flexibility subtest of the TAP (Zimmermann & Fimm, 2010), the recall phase of the CVLT (Delis et al., 1987), the incompatibility subtest of the TAP (Zimmermann & Fimm, 2010), the divided attention subtest of the TAP (Zimmermann & Fimm, 2010), and the Stroop task (Godefroy & GREFEX, 2008). After completing the manipulation check questionnaire, participants were thanked for their participation and fully debriefed about the real purpose of the study. In particular, the negative instructions in the diagnosis threat condition were denied. Participants were explained that spontaneous recovery and neuropsychological rehabilitation have a positive impact on cognition. They were also explained that everyone has control over their cognition. In addition to the oral debriefing, participants were given a written debriefing about the influence of negative stereotypes and poor self-confidence. Participants were given the opportunity to ask any questions they want and to contact the first author. No participant showed negative reactions in response to the debriefing.

Design and statistical approach

First, we run analyses (*t*-tests, ANOVAs, and chi-square test) to ensure equivalence between groups and conditions regarding demographics, baseline measures, and injury-related measures (Demographic characteristics and preliminary analysis, see below).

Then, we conducted a first set of regression-based analyses based on a 2 (Group: control vs. ABI) × 2 (Condition: reduced threat vs. diagnosis threat) between-subjects design. We examined the effect of the interaction between Condition and Group on the cognitive performance scores. This permits us to examine the impact of condition in each group.

Then, we run a second set of regression-based analyses only on participants with ABI. These analyses were based on a two groups, between-subjects design (reduced threat vs. diagnosis threat) with one continuous predictor (i.e., illness cognitions). We examined the effect of the interaction between Condition and Illness Cognitions on cognitive performance scores. The goal of these moderation analyses (Hayes, 2013) was to examine whether the size or sign of the effect of one variable (Condition: diagnosis threat vs. reduced threat) on the dependent variables (cognitive performance) is conditioned by another variable (participant group in the first set of analyses, illness cognitions in the second set). We chose regression analyses because these analyses enable us to keep the variable illness cognitions in its continuous metric, which provides more powerful analyses.

In this regression analyses, before computing conditional effects, the independent and moderating variables were mean-centred (see Hayes, 2013). For the participant group variable, the control group was contrast-coded −0.5 while the ABI group was contrast-coded + 0.5. As for Condition, the diagnosis threat condition was contrast-coded −0.5 while the reduced threat condition was contrast-coded + 0.5. Consequently, the *b* coefficient for condition, for instance, reveals the conditional effect of Condition when the Illness Cognitions factor was at its mean value (i.e., the effect of condition for participants who are moderate in illness cognitions).

Results

Demographic characteristics and preliminary analyses

All participants responded correctly to at least one item of the manipulation check questionnaire. As for the demographic data, an ANOVA with Group (ABI vs. control) × Condition (diagnosis threat vs. reduced threat) on age and a chi-square test on gender indicated equivalence between groups ($ps > .267$). Despite our efforts to match each patient with a control participant for years of education, the same ANOVA revealed that there was a significant difference between groups regarding years of education ($F(1, 70) = 5.73$, $p = .019$); participants with ABI ($M = 12.61$, $SD = .42$) had fewer years of education than control participants ($M = 14.00$, $SD = .40$). As well, the groups differed significantly on the FNART score ($F(1, 70) = 25.14$, $p < .000$), as participants with ABI ($M = 19.69$, $SD = .75$) performed worse than control participants ($M = 24.92$, $SD = .73$). There was also a significant difference ($F(1, 70) = 23.66$, $p < .000$) between groups regarding BDI-II score, with participants with ABI ($M = .81$, $SD = .06$) scoring higher for depression than control participants ($M = .38$, $SD = .06$). A significant difference between groups ($F(1, 70) = 5,88$, $p = .018$) was also observed on the hopelessness score; again, participants with ABI ($M = 5.25$, $SD = .54$) scored higher than control participants ($M = 3.42$, $SD = .53$). There was also a significant difference between groups on the STAI-YB score ($F(1, 70) = 4.38$, $p < .040$), with participants with ABI ($M = 2.27$, $SD = .09$) obtaining higher anxiety scores than control participants ($M = 1.99$, $SD = .09$).

In the group of participants with ABI, *t*-tests indicated no difference between conditions regarding time elapsed since injury and ICQ score ($ps > .233$). As well, chi-square tests indicated no difference between conditions regarding type of neurological disorder (TBI, cerebrovascular, and other), severity of the TBI, and whether or not they were still receiving cognitive rehabilitation ($ps > .219$) (see Table 1).

When FNART score was controlled for, there was no longer a significant effect of Group on years of education ($F(1, 69) = .30$, $p = .587$). As well, after BDI-II score was controlled for, Group no longer had a significant effect on the hopelessness score ($F(1, 69) = .00$, $p = .950$). We therefore controlled only for FNART, STAI-YB, and BDI-II scores in all subsequent analyses (i.e., Condition × Group design and Condition × Illness cognitions design). There was no task order effect on the cognitive scores ($ps > .583$).

Condition × group design

Memory score. As displayed in Table 2, participants with ABI had overall poorer memory performance than control participants. There was no overall effect of Condition and no Group × Condition interaction. More specifically, the simple slope of Condition for control participants was not significant ($b = .12$, $SE = .20$, $t = .61$, $p = .541$), confirming Hypothesis 1. The simple slope of Condition for participants with ABI was also non-significant ($p = .352$), but we predicted that this effect should be conditioned by the level of Illness Cognitions (see next analysis).

Attention score. There was no overall effect of Condition, Group, and no Group × Condition interaction. More specifically, the simple slope of Condition for control participants was not significant ($b = -.02$, $SE = .24$, $t = -.08$, $p = .940$), confirming Hypothesis 1. Again, the simple slope of Condition for participants with ABI was also non-significant ($p = .161$), but we predicted that this effect should be conditioned by the level of Illness Cognitions (see next analysis).

Table 1. Demographic and baseline data.

	Control participants		Participants with ABI	
	Diagnosis threat ($n = 19$)	Reduced threat ($n = 19$)	Diagnosis threat ($n = 18$)	Reduced threat ($n = 18$)
Age (years)	38.11 (11.48)	38.00 (12.19)	37.61 (11.18)	37.22 (12.18)
Gender (% female)	47.37	68.42	38.89	61.11
Education years*	14.32 (1.89)	13.68 (2.73)	13.44 (2.04)	11.78 (3.14)
FNART**	24.95 (3.34)	24.89 (4.12)	20.67 (5.12)	18.72 (5.17)
BDI-II**	.34 (.22)	.43 (.34)	.87 (.49)	.75 (.41)
Hopelessness*	3.11 (2.16)	3.74 (2.38)	6.22 (4.70)	4.28 (3.21)
STAI-YB*	1.83 (.44)	2.15 (.59)	2.33 (.63)	2.20 (.58)
ICQ			2.48 (.71)	2.78 (.75)
TSI (months)			28.06 (13.70)	26.39 (12.64)
TBI (%)			66.67	72.22
Mild TBI			27.78	11.11
Moderate TBI			0	5.56
Severe TBI			38.89	55.56
Cerebrovascular (%)			33.33	16.67
Other (%)			0	11.11
Cog. Rehab. (% yes)			50.00	55.56

Note. FNART = total score on the French National Adult Reading Test; BDI-II = mean score on the Beck Depression Inventory – second edition; STAI-YB = mean score on the Trait form of the State-Trait Anxiety Inventory; ICQ = total score on the Illness Cognition Questionnaire; TSI = Time elapsed since injury (months); TBI = percentage of participants with ABI who had sustained a traumatic brain injury; Mild TBI = percentage of participants who sustained a mild traumatic brain injury; Moderate TBI = percentage of participants who sustained a moderate traumatic brain injury; Severe TBI = percentage of participants who sustained a severe traumatic brain injury; Cerebrovascular = percentage of participants who had a sustained a cerebrovascular accident; Other = percentage of participants who had sustained another acute neurological disorder; Cog. Rehab. = percentage of participants receiving cognitive rehabilitation at the time of evaluation.

*$p < .05$.

**$p < .001$.

Table 2. Ordinary least squares regression model coefficients (standard errors) in the full sample and the participants with ABI sample.

	Full sample ($n = 74$)				Participants with ABI ($n = 36$)			
Outcomes →	Memory		Attention		Memory		Attention	
Predictors	Coefficient	P	Coefficient	P	Coefficient	P	Coefficient	P
Intercept	−0.83 (0.45)	.068	−1.32 (0.55)	.021	−1.79 (0.73)	.020	−3.29 (1.03)	.003
Gr.	−0.41 (0.18)	.024	−0.13 (0.22)	.555				
Cond.	0.15 (0.14)	.273	−0.19 (.0.17)	.288	0.12 (0.22)	.535	−0.44 (0.30)	.163
Gr. X Cond.	0.07 (0.28)	.812	−0.33 (0.35)	.343				
I. Cog.					0.44 (0.25)	.092	0.69 (0.36)	.065
I. Cog X Cond.					0.90 (0.29)	.005	0.59 (0.42)	.171
FNART	0.07 (0.02)	<.000	0.06 (0.02)	.004	0.08 (0.02)	<.000	0.08 (0.03)	.012
STAI-YB	−0.38 (0.19)	.047	0.03 (0.23)	.891	−0.22 (0.33)	.513	0.70 (0.46)	.141
BDI-II	−0.01 (0.28)	.985	−0.11 (0.35)	.761	0.13 (0.45)	.780	−0.20 (0.64)	.757

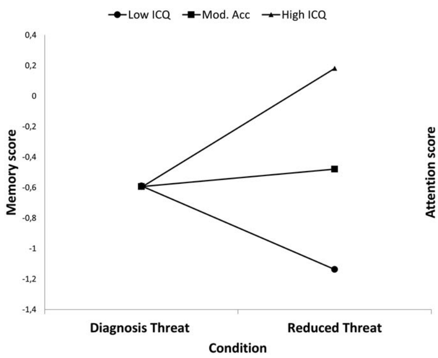
Note. Gr. = Group; Cond. = Condition; I. Cog. = Illness cognitions; FNART = total score on the French National Adult Reading Test; STAI-YB = mean score on the Trait form of the State-Trait Anxiety Inventory; BDI-II = mean score on the Beck Depression Inventory – second edition; Memory = memory score; Attention = attention score.

Condition × illness cognitions design in participants with ABI

For the main analyses that followed, we applied the Benjamini and Hochberg (1995) correction for multiple testing. This correction – which controls the expected proportion of type I errors – allows for an appropriate trade-off between type I and type II errors. Based on a .05 level of significance, after ordering the 10 p values (the 2 interaction p values and the 8 p values for the decomposition of the interactions), this correction set the level of significance at .02.

Memory score. As expected, there was no overall effect of Condition, but there was a significant interaction between Condition and Illness Cognitions (see Table 2). We probed this interaction using a pick-a-point approach that creates two values of the moderator: a low value (–1 SD) and a high value (+1 SD). There was a significant effect of Condition for participants with ABI who reported a high level of adaptive illness cognitions ($b = .78$, $SE = .31$, $t = 2.55$, $p = .017$, 95% CI = [.15, 1.40]); those participants performed worse in the diagnosis threat condition than in the reduced threat condition (Hypothesis 2b). There was no significant effect of Condition for participants with a low level of adaptive illness cognitions ($b = –.55$, $SE = .31$, $t = −1.79$, $p = .083$, 95% CI = [−1.17, .08]) (see Figure 1). Symmetrically, the results showed that there was an effect of Illness Cognitions only in the reduced threat condition ($b = .89$, $SE = .28$, $t = 3.19$, $p = .003$, 95% CI = [.32, 1.47]), in which higher levels of acceptance led to better performance (Hypothesis 2a), and not in the diagnosis threat condition ($p = .985$). Additional analysis revealed that participants with ABI who had a relatively high level of adaptive illness cognitions (from the 50th percentile, $N = 11$) had memory scores in the reduced threat condition at the same level as those of the control participants (mean difference of –.42, 95% confidence interval, 1000 bootstrap resamples [–1.10; .17], $p = .24$). The same analysis carried out for participants with ABI in the stereotype threat condition ($N = 7$) revealed that they underperformed compared to control participants (mean difference of –.93, 95% confidence interval, 1000 bootstrap re-samples [–1.45; –.49], $p = .02$).

Attention score. There was no overall effect of Condition and no significant interaction between Condition and Illness Cognitions. Decomposition of this interaction showed no effect of Condition for participants with ABI who reported high levels of adaptive illness cognitions (at + 1 SD; $p = .991$), invalidating Hypothesis 2b. As well, there was no significant effect of condition for participants with low levels of adaptive



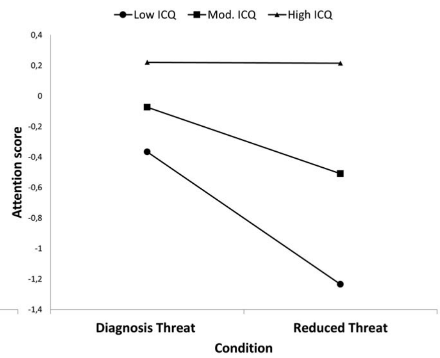


Figure 1. Effect of condition on (memory and attention) performance for participants with ABI depending on their level of adaptive illness cognitions.

Note. ICQ = Score on the Illness Cognitions Questionnaire (ICQ; Evers et al., 2001). The left part of the figure concerns memory score while the right part relates to attention score.

illness cognitions ($b = -.87$, $SE = .43$, $t = -2.00$, $p = .054$, 95% CI = [−1.75, .02]). Symmetrically, there was an effect of Illness Cognitions only in the reduced threat condition ($b = .98$, $SE = .40$, $t = 2.48$, $p = .019$, 95% CI = [.17, 1.80]), where higher levels of acceptance led to better performance (Hypothesis 2a), but not in the diagnosis threat condition ($p = .368$).

Clinical significance of memory performance for participants with ABI

Our analyses revealed that participants with a high level of adaptive illness cognitions performed worse in memory under diagnosis threat than in the reduced threat condition. We conducted further analyses to investigate whether the diagnosis threat condition might lead participants with ABI with high levels of adaptive illness cognitions to obtain more "impaired" memory performance, namely performance below the cut-off scores established from the normative mean (as opposed to "normal" performance). To do so, we compared the performance of participants with ABI to the normative data available for each memory task. If participants scored below −1.65 SD from the mean of the normative data for one memory task, they were classified as "impaired" and coded "1". Otherwise, they were classified as "normal" and coded "0". We therefore conducted logistic regressions with the same independent variable, moderator, and covariates as in the previous analyses. After ordering p values (interaction and specific contrasts), the Benjamini and Hochberg (1995) correction set the level of significance at .033. There was a trend toward an effect of Condition (*log-odds* = −2.56, $SE = 1.23$, $Z = -2.08$, $p = .038$), suggesting more impaired performance in the diagnosis threat condition than the reduced threat condition. Even more interestingly, there was a significant interaction between Condition and Illness Cognitions (*log-odds* = −4.68, $SE = 2.07$, $Z = -2.26$, $p = 024$). When we probed this interaction, the results showed no effect of Condition for participants with a low level of adaptive illness cognitions (*log-odds* = .90, $SE = 1.61$, $Z = .56$, $p = .578$), but a significant effect of condition for those who reported high levels of adaptive illness cognitions (*log-odds* = −6.01, $SE = 2.26$, $Z = -2.66$, $p = .008$). Participants with a high level of adaptive illness cognitions performed significantly worse in the diagnosis threat condition than their counterparts in the reduced threat condition (Hypothesis 3). More specifically, the risk that patients with ABI who had more adaptive illness cognitions would score below the clinical threshold was nearly twice as high in the diagnosis threat condition as in the reduced threat condition (OR = 0.002). Apart from a trend toward an effect of FNART score ($b = -.25$, $SE = .13$, $Z = -1.97$, $p = .049$), suggesting that higher premorbid intellectual level was associated with less impaired performance, there was no other significant effect ($ps > .246$).

Discussion

The goal of this study was to examine the influence of adaptive illness cognitions and diagnosis threat on the cognitive performance of participants with ABI. Our results showed that the cognitive performance of control participants was not affected by diagnosis threat. Conversely, whereas a high level of adaptive illness cognitions was associated with higher memory and attention performance in the reduced threat condition, diagnosis threat significantly reduced the memory (but not attention) performance of people with a high level of adaptive illness cognitions. Finally, diagnosis threat significantly increased the risk of impaired memory performance in people with ABI who had a high level of adaptive illness cognitions.

In agreement with numerous studies conducted with a wide range of diseases (Bossema et al., 2011; Van der Werf et al., 2003; Viane et al., 2004), a high level of adaptive illness cognitions had a beneficial impact on cognitive performance (memory and attention) in people with ABI under optimal conditions (no threat). Additional analyses showed that, under the reduced threat condition, participants with ABI and a relatively high level of adaptive illness cognitions (above the 50th percentile) performed as well as control participants on memory tasks. Previous studies had shown that a high level of adaptive illness cognitions leads to a better quality of life and fewer emotional disorders in people with ABI (Townend et al., 2010; Van Mierlo et al., 2015a). To our knowledge, though, this is the first study to show that a higher level of adaptive illness cognitions is linked to better cognitive performance (under optimal conditions). This effect could be because people who have a high level of adaptive illness cognitions engage more effort and resources during tasks (Matthews, Warm, Reinerman, Langheim, & Saxby, 2010). It could also be because people feel more confident and less anxious when facing cognitive tasks (Clarke & MacLeod, 2013). Our results highlight the necessity for neuropsychologists to focus not only on the rehabilitation of cognitive functions, but also on psychosocial variables that can influence task results. In this regard, several studies have been published on the efficacy of interventions aimed at increasing acceptance and self-esteem (self-concept) in people with neurological disorders (Joosten-Weyn Banningh et al., 2008; Vickery, Gontkovsky, Wallace, & Caroselli, 2006). These studies are in line with the recommendations made by several authors about the need to adopt a holistic rehabilitation approach with patients suffering from ABI (e.g., Ben-Yishay, 2000).

Although a higher level of adaptive illness cognitions was associated with better cognitive performance under the reduced-threat condition, this study also showed that diagnosis threat depleted the memory performance of people with ABI who have developed a high level of adaptive illness cognitions. Consequently, diagnosis threat wiped out the beneficial effect of acceptance. In fact, under diagnosis threat conditions, illness cognitions have no more positive impact on cognitive performance. More interestingly, while participants with ABI and a moderate to high level of adaptive illness cognitions performed memory tasks as well as control participants in the reduced threat condition, this was no longer the case when they were confronted by diagnosis threat. The fact that participants with ABI show poorer performance after listening to information regarding their problems and their alleged uncontrollability is in accordance with the studies conducted by Kit et al. (2014). Our results and those of Kit et al. (2014) showed that the neuropsychological assessment of people with ABI could be biased by negative stereotyping and instructions regarding the controllability of performance. Even more interesting, it was specifically people who had developed a high level of adaptive illness cognitions who showed a decline in performance under diagnosis threat. This result is in line with the broader stereotype threat literature. For example, stereotype threat was shown to interfere even more (or exclusively) with the calculus performance of advanced undergraduate women majoring in mathematics-related fields who strongly valued mathematics and who already had a good calculus GPA (Steinberg, Okun, & Aiken, 2012). Likewise, the effect was found to impair the memory performance of older persons for whom having an efficient memory was important (Hess et al., 2003). In addition, with people reporting a history of mTBI, we showed that (implicit) diagnosis threat decreases neuropsychological performance of people for who having efficient cognitive capacities was important (Fresson, Dardenne, & Meulemans, 2018). Consequently, as postulates in the stereotype threat theory (Steele & Aronson, 1995), diagnosis threat could specifically impacts people who would perform the best in optimal conditions.

Beyond its impact on raw task performance, our results showed that diagnosis threat increased the likelihood that participants with moderate and high levels of adaptive illness cognitions would produce impaired performance (i.e., performance significantly below the pathological cut-off score based on normative data) on memory tasks. Other studies had shown that stereotype threat, in the case of neurologically normal older persons (Haslam et al., 2012), and diagnosis threat, in the case of people with ABI (Kit et al., 2014), often induce clinical impairment on neuropsychological tasks. These findings show that stereotypes can interfere with the validity of neuropsychological assessment, even in the chronic stage of neurological disorders. False positive results indicating impaired memory functioning could have a detrimental impact on neurological patients. With time, people with ABI could develop a poor sense of self-efficacy, leading to disengagement from the rehabilitation process. In turn, this could negatively impact their performance, in a vicious circle. In this respect, it is interesting to note that simple instructions aimed at reducing stereotypic cues and enhancing feelings of control over cognitive functioning permitted neurological participants with high levels of adaptive illness cognitions to perform at their best (see also Kit et al., 2014), even at the same level of performance as control participants.

In this study, diagnosis threat impacted only memory tasks, not attention tasks. Several explanations can be advanced for this differential impact. The results of the first set of analyses investigating the interaction between group and condition showed an effect of group only for memory tasks, not for the attentional ones. Participants with ABI and neurologically normal controls performed equally well on attention tasks. Stereotype threat has been found to impact only objectively (O'Brien & Crandall, 2003) or subjectively (Schuster, Martiny, & Schmader, 2015) difficult tasks. If neurological participants performed as well as control participants in attention tasks, one can assume that these tasks were not difficult enough to trigger a deleterious impact of diagnosis threat. As well, if neurological participants have recovered their attentional capacities and consequently do not face attentional difficulties in everyday life, they may not have felt threatened at all by the diagnosis threat instructions when they completed these tasks. Finally, executive and working memory resources are known to be especially depleted by stereotype threat (Schmader, Johns, & Forbes, 2008). Possibly, the memory tasks we chose involved more executive and working memory resources than the attentional tasks.

Although our study suggests that diagnosis threat can impair memory performance in people with ABI – more specifically, it can eliminate the beneficial effect of adaptive illness cognitions on these outcomes – our study has some limitations. First, to reduce the number of statistical analyses, we calculated a global index of "adaptive illness cognitions" by averaging items of the three subscales of the illness cognitions scale (with the helplessness items reversed). However, some studies have shown that each of these dimensions may constitute an independent (of the two others) predictor of health and well-being outcomes (e.g., Eglinton & Chung, 2011). Future studies should consider the respective effect of each kind of illness cognition (helplessness, acceptance, and perceived benefits) on cognitive performance. Secondly, our sample of participants suffered from cognitive disorders due to various aetiologies (mostly cerebrovascular accident and TBI). However, this study concerned not the effect of a particular aetiology on cognitive functioning but the effect of diagnosis threat in a sample of participants for whom the threat would be relevant. All our participants had to have received or still be receiving cognitive therapy for their cognitive disorders. Statistical analyses assured us that the random allocation of participants was successful at creating groups that included the same number of participants by aetiology, time since injury, participation to cognitive rehabilitation, etc. Subsequent studies should address the specificity of neurological disorders regarding illness cognitions and diagnosis threat. For instance, we did not include participants with degenerative neurological disorders because one can assume that these patients could have different illness cognitions from patients with non-degenerative neurological conditions and thus could respond differently to diagnosis threat.

Conclusions

Our study showed that, for people with ABI under a reduced threat condition, a high level of adaptive illness cognitions was associated with better memory performance. However, when facing diagnosis threat, their memory performance was likely to diminish and could even reach pathological levels (i.e., below the limits of the normative data). This study indicates the need for clinicians to take into account environmental and psychosocial factors that can influence the performance of people with ABI and their rehabilitation process in general.

Note

1. We also administered the personal control and treatment control subscales of the Illness Perception Questionnaire – Revised (IPQ-R; Moss-Morris et al., 2002) to these participants. However, these measures are not analysed in the present study.

Geolocation information

This study has been conducted with Belgian participants.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendix

Reduced threat condition

Scientific research shows that people who have sustained a neurological disorder, such as a traumatic brain injury or cerebrovascular accident, usually recover fully after a period of time. Consequently, on memory and attention tasks, individuals who have had a neurological disorder perform as well as individuals who have not had a neurological disorder. Scientific research also shows that everyone can control or influence their own memory and concentration. In other words, one can improve one's memory and attention with effort. It is therefore always possible to improve one's memory and attention capacities by working on it and making an effort. Moreover, people who see a neuropsychologist for rehabilitation/therapy improve quickly. Indeed, working on memory and concentration exercises does permit the brain to fully heal. The goal of this study is to confirm the above findings. To do this, you will complete several attention and memory tests.

Diagnosis threat condition

Scientific research shows that people who have sustained a neurological disorder, such as a traumatic brain injury or cerebrovascular accident, usually do not recover fully, even after a period of time. Consequently, on memory and attention tasks, individuals who have had a neurological disorder perform worse than individuals who have not had a neurological disorder. Scientific research also shows that no one can control or influence their own memory and concentration. In other words, one cannot improve one's memory and attention, even with effort. It is therefore not possible to improve one's memory and attention capacities by working on it and making an effort. Moreover, people who see a neuropsychologist for rehabilitation/therapy do not improve quickly. Indeed, working on memory and concentration exercises does not permit the brain to fully heal. The goal of this study is to confirm the above findings. To do this, you will complete several attention and memory tests.