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MENTALISATION ERRORS IN AN ACQUIRED BRAIN INJURY SAMPLE ON THE RECOGNITION OF FAUX PAS TEST

ERRORES DE MENTALIZACIÓN/TEORÍA DE LA MENTE EN UNA MUESTRA DE LESIÓN CEREBRAL ADQUIRIDA EN EL TEST DE RECONOCIMIENTO DE FAUX PAS

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Background: Mentalisation (also known as theory of mind) difficulties have been reliably demonstrated across different subtypes of adult acquired brain injury (ABI), and the role of such impairments in negative psychological and interpersonal outcomes for survivors and their significant others has been increasingly highlighted.

Aims & Methodology: This study aimed to characterise the most salient aspects of mentalising performance in a large ABI sample, relative to matched controls. The participants were 88 (64 male, 24 female) persons with acquired brain injuries (TBI; CVA; other subtypes) participating in community neuro-rehab services (mean age 45.2 years, SD 10.7; mean time since injury 6.69 years; range 1.5 – 31.3 years).) and 50 (34 male, and 16 female) healthy participants (mean age 45.3 years, SD 13.9). The main measure of mentalising operationalised in this study was the Recognition of Faux Pas Test (Stone et al., 2003), a story vignette task completed by patients and controls.

Results & Conclusions: Overall, the patient group made significantly more errors in detecting the presence of a faux pas than the matched control group (t (132)=2.24, p<.05, Cohen's d = 0.4), reflective of 1st order mentalising difficulties in the ABI group. However the patients did not make more errors than controls in explaining the reason for the faux pas (p=.75). Patterns in errors made by the patient group are explored, and implications for rehabilitation are discussed.

Keywords: Acquired Brain Injury, Theory of Mind, social cognition, Faux Pas, Neuropsychological Rehabilitation.

Antecedentes: Las dificultades de mentalización (también conocida como teoría de la mente, por sus siglas en inglés *ToM*) se han demostrado de forma fiable en diferentes subtipos de Lesión Cerebral Adquirida (LCA) en adultos, y se ha destacado cada vez más el papel de estas deficiencias en los resultados psicológicos e interpersonales negativos para los sobrevivientes y sus allegados.

Objetivos y metodología: El objetivo de este estudio es caracterizar los aspectos más destacados del rendimiento de la mentalización en una amplia muestra de LCA, en relación con controles emparejados. Los participantes fueron 88 (64 hombres, 24 mujeres) personas con lesiones cerebrales adquiridas (TEC, ACV, otros subtipos) que participaban en servicios de neurorrehabilitación de la comunidad (edad media 45.2 años, DE 10.7; tiempo medio desde la lesión 6.69 años; rango 1.5 - 31.3 años) y 50 (34 hombres y 16 mujeres) participantes sanos (edad media 45.3 años, DE 13.9). La principal medida de mentalización operacionalizada en este estudio fue el Test de Reconocimiento de Faux Pas (Stone et al., 2003), una tarea de historias en viñetas completada por pacientes y controles.

Resultados y conclusiones: En general, el grupo de pacientes cometió significativamente más errores en la detección de la presencia de un faux pas que el grupo de control emparejado (t (132)=2.24, p<0.05, d de Cohen = 0.4), lo que refleja las dificultades de mentalización de primer orden en el grupo de LCA. Sin embargo, los pacientes no cometieron más errores que los controles a la hora de explicar el motivo del faux pas (p=0.75). Se exploran los patrones de los errores cometidos por el grupo de pacientes y se discuten las implicaciones para la rehabilitación.

Palabras claves: Lesión cerebral adquirida, teoría de la mente, cognición social, faux pas, rehabilitación neuropsicológica

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INTRODUCTION

The ability to recognize and make inferences about other people's intentions and beliefs is often referred to as theory-of-mind (ToM) and this ability would be important for effective interpersonal communication. ToM as an ability is underpinned by a distributed neural substrate. A range of areas with the frontal and temporal lobes have been implicated (Frith & Frith, 2006; Samson et al., 2005) and dysfunctions in any of these areas could disrupt ToM (Adams, Schweitzer, Molenberghs & Henry, 2019). There are substantial interindividual differences in ToM and the ability can be disturbed in developmental disorders or impaired following brain damage (Channon & Crawford, 2000; Happé, Malhi, Checkley, 2001). Early research into ToM deficits focused primarily on developmental disorders, such as autism and Asperger's syndrome (e.g. Baron-Cohen, Leslie & Frith, 1986; Leekam & Perner, 1991), but there is also convincing evidence for acquired deficits in ToM following brain damage in adult patients, such as strokes or traumatic brain injury (e.g. Martin-Rodriquez & Leon-Carrion, 2010). Such difficulties in adult survivors of acquired brain injury have been associated with a range of negative psychosocial outcomes, including fewer relationships (Blonder, Pettigrew, & Kryscio, 2012), poorer community integration (Struchen, Pappadis, Sander, Burrows, & Myszka, 2011), poorer relationships with work colleagues (Yeates et al., 2016) and poorer therapeutic working alliance with rehabilitation clinicians, thereby influencing rehabilitation outcome (Schönberger, Yeates & Hobbs, in press). Impairments in ToM and understanding intentions were also associated with social behaviour and behavioural changes following TBI, more severe impairments in ToM were associated with poorer social behaviour and social outcome (Milders, 2018; Struchen et al., 2011). Therefore, ToM ability following ABI can also be relevant for understanding the factors that contribute to changes in social behaviour post-injury and as potential target for rehabilitation in order to improve social outcome.

Assessment of ToM in adult patients requires different measures than those that had been developed for use in children. A popular test for adult ToM is the Faux Pas test (Stone et al., 1998), which consists of vignettes with or without someone saying something inappropriate due to a false belief. Each story vignette is usually followed by two questions pertaining to faux pas (FP) detection ("did someone say something that they shouldn't have said?...who?"), one question inviting representations of the mental states of those affected by the FP, and related social norms ("why shouldn't they have said it?") and finally a question about the intentions of the protagonist who committed the FP ("why did they do it?"). A later version of the task also includes questions pertaining to the emotional states of characters and a clarification of the respondent's understanding of characters' false beliefs. There are additional questions that identify if basic levels of story comprehension have been met by respondents.

In an earlier study we found that patients with traumatic brain injury (TBI) performed significantly poorer relative to controls when explaining the reason for the faux pas, which required understanding or explaining the intentions and feelings of the characters (Milders et al., 2006). A quantative review by Martin-Rodriquez and Leon-Carrion (2010) of studies into ToM in acquired brain injury published prior to 2008 identified 9 studies that used the Faux Pas and in all studies patients were significantly impaired (with an overall moderate to large effect size, Cohen's d = .70) compared to healthy controls. Sample sizes varied between 9 and 41 patients. Across the different studies a positive association was found between the presence of acquired brain injury and faux pas performance. Studies with larger proportion of patients with TBI tended to show larger effect sizes. In addition, the presence of frontal lesions and lesions in the right hemisphere was associated with larger effect sizes.

More recent studies using the Faux Pas Test have identified impairments in ToM in participants with different forms of acquired brain injury. Bivona et al. (2014), Geraci et al. (2010), McLellan et al. (2013) and Muller et al. (2010) reported impaired Faux Pas performance in patients with TBI relative to healthy controls. Patients with moderate to severe TBI (McLellan et al., 2013) or with lesions in the ventromedial frontal area were particularly impaired on the Faux Pas test (Geraci et al., 2010), although their sample was small (n=11). This finding was confirmed in a study in patients with penetrating head injury (Leopold et al., 2012) Patients with ventromedial prefrontal lesions were impaired on the Faux Pas test. Lee et al. (2010) also found impaired Faux Pas performance in patients with medial frontal lesions as a result of surgical tumour removal. ToM deficits have been identified using other measures in patients with temporal cortical lesions (Olson et al., 2007) and in mixed right hemisphere cerebro-vascular accidents, including both anterior and posterior infarcts (Happé et al., 1999). These findings

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suggest that ToM impairment in adult patients, as assessed with the Faux Pas task are common in patients with varied forms of acquired brain damage that impact on the distributed neuro-anatomical substrate for ToM.

However, there are two key methodological limitations of previous research. Firstly, the sample size in individual studies was limited, with the number of patients in most studies lying below 30. Secondly, although ToM impairments were found with different etiologies of brain damage, comparison of etiology required comparison across studies, as each study typically included only patients with the same etiology. When comparison between different studies, there is a risk that other differences (e.g. in methods or analysis), could account for the etiology group differences. In addition, there is a conceptual confusion, reflected in measurement and scoring methodologies in previous studies using the Faux Pas test. The majority of researchers have used the total scores summed from all questions pertaining to the vignettes that contain an incident of faux pas. These vignettes each are followed by four to six sub-questions (depending on which version of the task is used) for respondents that actually assess different aspects of ToM/mentalising. These include questions relating to 1st order versus 2nd order mentalising representations. First order mentalising refers to beliefs and/or intentions of characters affected by the faux pas who are privy to different information within each story. Second order mentalising involves the intentions of the character committing the faux pas towards the other characters, given their incomplete knowledge/naïve position within the story. Additionally, there are questions that elicit epistemic representations (pertaining to others' knowledge, beliefs and/or intentions) versus affective representations (others' feelings and emotional states). In most studies using the Faux Pas test in these different representational types, and any differences in respondents' abilities towards each, were conflated within the faux pas total score. This confusion is significant for both theoretical and clinical reasons. In a rare exception to the aforementioned literature, Lee et al., (2010) found that responses on the question of each faux pas story concerning the motivation of the protagonist ("why did they do it?") discriminated patients with ventro-mesial versus dorso-lateral surgical lesions, with the former performing significantly worse on this question than the latter. This question type relates specifically to a respondent's ability to represent the intentions of the protagonist in each story, as a function of the character's incomplete knowledge within the social situation (thereby requiring 2nd order representations – the character's beliefs about others' beliefs). Happé (1998) has highlighted the prevalence of deficits in 2nd order representations within her right hemisphere CVA adult sample, whereas other researchers have highlighted the importance of negative hostility bias in different samples of brain injury survivors' representations of others' intentions (Knox & Douglas, 2008; Neumann et al., 2015; Stone et al., 1998; 2003; Zupan et al., 2014).

Given the above findings, conflating the accuracy of different levels and types of mentalising representations in patients' responses may reduce sensitivity to important neuro-anatomical differences in mentalising functions and the pathology of such in different clinical groups. Furthermore, clinicians may be differentially focusing on different types of ToM representation in their social cognition/psychotherapy interventions with these clinical groups, depending on the goals/foci of the work concerned. As such, clinicians would benefit from a knowledge base that teases out these sub-abilities and their relevance to other clinical outcomes. The study reported here used the Faux Pas test on survivors with acquired brain injury due to different etiologies and matched healthy controls in what might be the largest patient sample to date. Importantly, alongside total scores, responses to different Faux Pas question types (and the different mentalising abilities to which they pertain) were scored separately, along with categorization of characteristics in the erroneous responses. The goal of the study was to use a finer level of discriminatory analysis and to compare response patterns in different etiologies and different lesion locations.

METHOD

Participants

The participants were 88 (64 male, 24 female) persons with acquired brain injuries (mean age 45.2 years, SD 10.7) and 50 (34 male, 16 female) healthy participants (mean age 45.3 years, SD 13.9). The patients were recruited through three community rehabilitation services in the United Kingdom (Community Head Injury Service, Aylesbury and two Momentum Skills services in Birmingham and Newcastle). Healthy participants were recruited from the general population to match the patients for age and proportion of males and females. The patients had suffered acquired brain injury, with different aetiologies: traumatic

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brain injury (40), CVA (35), hypoxia (3), infection (5), tumour (1) or other (4). Information on lesion location was available for 72 patients, from acute clinical documentation of relevant neuro-imaging and was categorized as frontal (21), posterior (16), subcortical (9) or diffuse (24). Mean time since injury in the patient group was 6.69 years (range 1.5 – 31.3 years). All participants gave informed consent to take part in the study, which had been approved by the Oxfordshire Research Ethics Committee B.

Faux Pas task

Faux Pas Test (Stone et al., 1998). This test consists of 20 vignettes, 10 describing a social faux pas, 10 without faux pas. After participants are read each story, they answer a number of questions while keeping the story in front of them. The first question is whether someone had said something they should not have said? If question 1 is answered yes, three further questions are asked, 1. Who said something they should not have said? 2. Why should they not have said it? 3. Why do you think they said it? A final and fifth question to test the general understanding of the stories is asked, regardless of the answer to the first question. Following stories without faux pas, two questions are asked that assess detection of the (absence) of the faux pas and comprehension of the story (control question). Participants could receive 1 point on each question for a correct response and no points for an incorrect response. Faux Pas items were presented one-by-one and intermingled with items that did not contain a faux pas. The items were presented in a semi-random order. The items without faux pas were merely included to make participants aware that not all items contained a faux pas and responses to these items were not analysed further.

Verbal responses of the participants were recorded on the scoring sheet and scored following predetermined guidelines. If participants made an incorrect response, a distinction was made between different types of errors. First order errors were recorded if a participant failed to detect the presence of a faux pas (i.e. responding "no" to question 1) or provided an incorrect response to questions 2 or 3, which indicated a failure to understand that a faux pas had been made. Incorrect explanations of the reason for the faux pas (incorrect response to question 4), which indicated that the participant had not fully understood the faux pas arose from false belief, were further recorded as second order errors and subdivided into omission and commission errors. In omission errors the explanation refers only to the intentions of the perpetrator of the faux pas, without referring to the recipient of the faux pas (e.g. he thought it was funny). In commission errors the explanation did refer to the recipient or person affected by the faux pas, but do not take into account the element of false belief or lack of information (e.g. he though the joke would cheer everyone up.). The four categories of error scores (1st order, 2nd order total, 2nd order omission, 2nd order commission) were the main variables of faux pas performance that were compared between the participants groups. The responses were scored by two independent raters (MM and GY). Agreement between raters, based on a random sample of responses from 10 participants, was good (r=0.83).

RESULTS

Performance of the group of people with acquired brain injuries and the healthy control group on the 10 items containing a faux pas is displayed in Table 1. Performance is expressed as the number of errors detecting the presence of a faux pas (1st order errors), errors explaining the reason for the faux pas and the mental state of person making the faux pas in response to question 4 on each vignette (2nd order errors) and control scores representing general understanding of the story.

Overall, the patient group made significantly more errors in detecting the presence of a faux pas than the matched control group (t (132)=2.24, p<.05, Cohen's d = 0.4) but the patients did not make more errors than controls in explaining the reason for the faux pas (p=.75). Note that only when participants had correctly indicated the presence of a faux pas, they were asked to explain why they thought the faux pas had occurred. Because the number of detection errors was higher in the patient group, the number of explanations of faux pas that a participant made, was divided by the number of explanation questions that they had attempted. Comparing this proportion of explanation errors between the two groups again revealed no significant difference between the patients and controls (p=.63) (see Table 1).

Errors in explaining the reason for the faux pas were further subdivided into omission errors (not referring to the perpetrator attitude towards the recipient of the faux pas, only to the perpetrator's own intentions) and commission errors (including the perpetrator attitude towards the recipient of the faux pas, but not taking into account false belief or lack of information as an explanation for the faux pas).

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The mean number of omission and commission errors in the two groups are shown in Table 1. Between- group comparisons showed no significant differences on either omission or commission errors (p>.8). Comparing the proportion of omission and commission errors divided by the number of times that the explanation questions had been attempted, also revealed no difference between the patient and control groups (p>.66).

General comprehension scores were very high in both the patient and the control group, but the patients made slightly more errors than controls, who made none (t (134)=2.25, p<.05). Errors on the comprehension questions may indicate that the patients had not fully understood the vignette. If they had not fully understood the vignette, the errors on the questions concerning the faux pas may not reflect problems understanding intentions and false belief. In order to rule out that lack of understanding of the vignette resulted in errors on the faux pas related questions, the analyses were repeated including only those patients who made no errors on the comprehension question (n=74). The results were comparable to those obtained with the full patient sample; the number of first order errors was higher in the patient group than in the controls, the difference being nearly significant (t(120)=1.94; p=.054), but the number of second order errors was similar in the two groups, suggesting that even when comprehension of the vignettes was intact, detecting a faux pas was still poorer in the patient group than in the healthy comparison group.

The brain injured group contained a range of etiologies, the most frequent being traumatic brain injury (TBI) and stroke or cardiovascular accident (CVA). To examine whether etiology influenced performance on the faux pas test, the patient group was subdivided in a group of patients with TBI (n=40) and a group of stroke patients (n=35). Faux pas scores of these two subgroups are displayed in Table 2. Comparing Faux Pas performance in the TBI group and the CVA group showed no difference on any of the Faux Pas scores between the two groups.

For 72 of the brain injured patients information on lesion location was available. To examine whether location of the lesion influenced performance, regardless of aetiology, patients for whom lesion location was available were grouped into a group with predominately frontal lesions (n=21) , a group with posterior lesions (n=16) and a third group with diffuse lesions (n=24). Detection errors, explanation errors and scores on the control questions were compared between these three lesion groups (see Table 3). One-way ANOVA revealed no significant group differences on any of faux pas scores (p>=.49). Lesion location in this sample had not significant effect on faux pas performance .

DISCUSSION

Patients with acquired brain injury were significantly poorer than healthy participants at detecting the presence of a faux pas. Contrary to expectation, explaining the reason for the faux pas, which requires understanding the intentions

Table 1. Performance on the faux pas test in the patient and control groups

		Patients with ABI (n=84)		Controls (n=50)	
		M	**(SD)**	**M**	**(SD)**
1st order errors: failure to detect presence of a faux pas (max = 20)		4.98*	(3.45)	3.48	(4.18)
2nd order errors:Errors explaining faux pas		3.82	(2.89)	3.94	(2.00)
Proportion errors explaining faux pas		0.51	(0.28)	0.48	(0.23)
	Omission errors	2.68	(2.31)	2.74	(1.61)
	Proportion omission errors	0.35	(0.28)	0.34	(0.21)
	Commission errors	1.14	(1.14)	1.20	(1.47)
	Proportion commission errors	0.15	(0.16)	0.14	(0.16)
Control question (number correct)		9.72*	(6.43)	10	0.0

*Significantly different relative to healthy comparison group, p<.05

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Table 2. Performance on the faux pas test in those patients who had suffered traumatic brain injury or stroke.

		Patients with TBI (n=40)		Patients with stroke (n=35)	
		M	**(SD)**	**M**	**(SD)**
1st order errors: Failure to detect presence of faux pas		5.26	(3.49)	4.45	(3.08)
2nd order errors: Errors explaining faux pas		4.13	(2.41)	3.45	(2.04)
Proportion errors explaining faux pas		0.55	(0.28)	0.45	(0.26)
	Omission errors	2.82	(2.44)	2.27	(2.02)
	Commission errors	1.31	(1.23)	1.18	(1.10)
Control question (number correct)		9.77	(0.67)	9.80	(0.58)

Table 3. Performance on the Faux Pas test in those patients with predominantly frontal lesions, posterior or subcortical lesions or diffuse lesions

		Frontal (n=21)		Posterior (n=16)		Diffuse (n=24)	
		M	**(SD)**	**M**	**(SD)**	**M**	**(SD)**
1st order errors: Failure to detect presence of faux pas		5.39	(2.99)	4.46	(3.44)	5.35	(4.59)
2nd order errors: Errors explaining faux pas		3.55	(2.30)	3.33	(2.19)	3.96	(2.36)
	Omission errors	2.34	(2.03)	2.00	(2.36)	2.91	(2.23)
	Commission errors	1.21	(1.35)	1.33	(0.72)	1.05	(1.18)
Control question (number correct)		9.87	(0.34)	9.67	(0.81)	9.74	(0.75)

of others and 2nd order mentalising representations, was not impaired in this patient sample. Overall, the patient group was impaired at recognizing the presence of a faux pas, suggesting that once they had detected the presence of a faux pas, the patients performed as well as healthy participants in explaining the faux pas, and on none of the error scores did the patients score more poorly than controls. The impairment in detecting the presence of a faux pas in the brain injury patients could not be explained by difficulties understanding the gist of the faux pas story. Even those patients whose performance on the question assessing general comprehension was flawless, performed more poorly than controls in detecting the presence of a faux pas. Within the group of patients, aetiology of the brain damage had little effect on performance. Patients with traumatic brain injury or CVA, by far the largest aetiology groups in this sample, performed very similar on the task. Suspected location of the brain lesion also had little effect on faux pas recognition. Faux pas detection scores and error scores did not differ between subgroup of patients with predominantly frontal, posterior or diffuse lesions.

This study reported understanding of other people's intentions as tested using the Faux Pas test and relative to matched healthy controls in one of the largest samples of patients with acquired brain injuries to date. As expected, the results show poorer faux pas detection (requiring 1st order mentalising representations) in brain injured participants. Some studies have reported poor performance on the Faux Pas test in brain injured participants not in detecting the presence of a faux pas, but in explaining the faux pas or in 2nd order mentalising (Happe et al., 1998; Lee et al., 2014; Milders et al., 2006). However, most studies reported only total Faux Pas scores for their patient samples, without specifying the main source of errors. Based on the

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findings of the current study, the main impairment might have been in detecting the presence of a faux pas. Previous studies found patients with prefrontal lesions to be more impaired on the Faux Pas test than patients with lesions in other regions (Geraci et al., 2010; Gregory et al., 2002; ; Leopold et al., 2012), whereas in the current sample performance in patients with frontal lesion did not differ from those with posterior or diffuse lesions. The cause of the brain injury also had no important impact on performance on the Faux Pas. Previous studies into the effect of brain injury on understanding intentions tended to include patients with a single aetiology (e.g. TBI or CVA). In the current study patients with TBI performed no different from patients who had suffered a CVA on the Faux Pas task. Together with the finding that lesion location had no impact on performance, the results of this study suggest that the presence of cortical lesions was the main factor for impairments on the Faux Pas test, rather than the exact location or the aetiology of the brain damage.

This conclusion is not in line with other studies that showed more severe impairments on the Faux Pas task in patients with frontal lesions, and in particular medial frontal lesions (Geraci et al., 2010; Lee et al, 2010; Leopold et al., 2012), or that impairments in patients with TBI tended to be more severe that in other forms of acquired brain injury (Martin-Rodriquez & Leon-Carrion, 2010). One of the limitation of the current study was that lesion location in the patient sample was typically based on CT scans, which may be less precise than the surgical lesions in study by Lee et al. (2010) or the localised lesion in the study by Leopold et al. (2012). We were not able to discriminate ventro-mesial and dorsolateral frontal lesions, an important distinction for some aspects of mentalising according to Lee et al., (2010). As a result, less precise lesion localization could have made it more difficult to identify a link between Faux Pas performance and lesion location in the current sample. On the other hand, mentalising and ToM abilities would rely on widespread brain networks (Adams et al., 2019; Frith & Frith, 2006), making it plausible that these abilities can be affected by lesions in various locations due to different aetiologies. Another limitation of the current study was that for the majority of participants with brain injury no information was available on severity of brain injury. As a result, it is unclear whether the pattern of impaired detection and correct explanation of faux pas was due to relatively mild brain injuries in the current sample and it is unclear how the current sample compares to samples in previous studies that found Faux Pas impairments typically following moderate to severe brain injury. A further limitation of the study was that post-injury behaviour or changes in behaviour were not assessed in this sample. Although changes in behaviour following acquired brain injury are not rare (Baguley et al., 2006; Benedictus et al., 2010; Kelly et al., 2008) and impairments in understanding intentions and ToM are associated with post-injury behaviour (Milders, 2018; Struchen et al., 2011), the current study cannot confirm this link.

In sum, patients with acquired brain injury were impaired at detecting the presence of a faux pas, regardless of aetiology, but performed as well as healthy controls in explaining the reason the faux pas, which requires 2nd order mentalising. Mentalising in survivors of acquired brain injury has become a focus of rehabilitation intervention (Spikman et al., 2013), and has been shown to be a critical influence on the therapeutic working relationship between survivors and clinicians, irrespective of the rehabilitation goal (Schönberger, Yeates & Hobbs, submitted). Specific mentalization-based psychotherapies have been applied to a range of clinical groups (Bateman & Fonagy, 2012) and Yeates (2014) has advocated for the use of such approaches with survivors of ABI to support survivor mental health and their relationships with others (including clinicians). If these interventions become more prominent within neuro-rehabilitation, the differing clinical significance of deficits in 1st order versus 2nd order mentalising representations, and/or epistemic, affective and intentionality representations will need to be discerned. While the current study only found impairments in 1st order representation and did not find significant differences between patients and controls on 2nd order or other mentalising indices, these findings need to be replicated with other brain injury and control groups and with additional measures.

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