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Improved comprehension of irony and indirect requests following a severe traumatic brain injury: two case studies

Natacha Cordonier [a,b], Maud Champagne-Lavau [b] and Marion Fossard [a]

[a]Faculté des lettres et sciences humaines, Institut des sciences logopédiques, Université de Neuchâtel, Neuchâtel, Suisse; [b]LPL CNRS, Aix-Marseille Université, Aix-en-Provence, France

ABSTRACT

Background: Following a traumatic brain injury (TBI), people frequently have difficulty understanding nonliteral language, including irony and indirect requests. Despite the handicap that these disorders can represent in daily life, they are rarely treated clinically, and remediation studies are scarce.

Aims: The present study thus aimed to evaluate the effectiveness of an explicit metapragmatic therapy targeting nonliteral language comprehension and taking into account cognitive processes likely to underlie this comprehension (i.e., contextual processing, theory of mind, and executive functions).

Methods & Procedure: This study was registered on the ClinicalTrials.gov system (ID: NCT04708561) before participant recruitment. Two adults with severe TBI took part in the study. An ABA design with multiple baselines was used to assess the evolution of treated and non-treated written literal and nonliteral story comprehension, as well as ecological tasks and tasks assessing the cognitive processes of interest (theory of mind and executive functions). An interview was also conducted at the end of treatment to assess participant satisfaction.

Outcomes & results: Therapy resulted in significant improvement in treated items, with one-month maintenance of gains and generalisation to untreated items in both participants. The generalisation to a working memory task was also observed in one participant. Finally, participant satisfaction with the treatment was high.

Conclusions & implications: Our study demonstrated for the first time the potential of a therapy targeting irony and indirect request comprehension in TBI individuals. Clinically, it offers concrete therapeutic avenues and fills a critical gap in the TBI population's evidence for the remediation of nonliteral language comprehension.

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CONTACT Natacha Cordonier natacha.cordonier@gmail.com Université de Neuchâtel, Rue Pierre-à-Mazel 7 2000 Neuchâtel, Suisse

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Introduction

Nonliteral language is ubiquitous in our daily lives. Whalen et al. (2009) demonstrated that 94% of the emails written by young adults contained at least one nonliteral statement. Irony (e.g., "What beautiful weather" pronounced in rainy weather) accounted for 8% of cases. This frequency of irony occurrence was also found in conversations between friends (Gibbs, 2000), blogs (Whalen et al., 2013), and TV shows (Dews & Winner, 1997). Besides irony, indirect requests (e.g., "It is cold" to ask to close the window) represent another common form of nonliteral language, with 80% of requests formulated indirectly (Gibbs, 1981). Given their frequency, a good understanding of these nonliteral statements is essential in our social interactions.

Following a traumatic brain injury (TBI), however, many individuals may have pragmatic disorders (Cummings, 2017), particularly affecting the comprehension of nonliteral language forms, such as irony (Bosco et al., 2018; Channon et al., 2005; Cordonier et al., 2020), indirect requests (Dardier et al., 2011; Zimmermann et al., 2011), or metaphors (Arcara et al., 2020). It has been demonstrated that these pragmatic deficits have significant repercussions on professional resumption, relationships with family and friends and can lead to social isolation and lower satisfaction in life (see Cummings, 2011 for a review). These repercussions are all the more disabling since pragmatic disorders can last several years after the TBI (Hammond et al., 2004; Snow et al., 1998). Therefore, targeted treatments for these disorders are essential.

Surprisingly, studies of nonliteral language therapies for TBI individuals are rare. In a systematic review of communication disorder treatment following TBI, Cordonier (2017) identified only one study specifically targeting nonliteral language comprehension (Brownell et al., 2013). This study aimed to improve metaphor understanding using a Thinking Map semantically linking the main concepts of metaphors. This method enabled to target "coarse semantic coding" processing (Beeman, 1998), minimising the load on working memory. Results showed significant improvement in metaphor comprehension in six of eight participants, with no significant change on a control task. In addition, treatment gains were maintained 3-4 months post-therapy in three participants. On the other hand, no significant change was found on a standardised test of metaphor comprehension (The Formulaic and Novel Language Comprehension Test, FANL-C; Kempler & Van Lancker-Sidtis, 1996). These results replicated those demonstrated two years earlier in participants with right-hemisphere damage (RHD) (Lundgren et al., 2011). They also supported the possibility of improving metaphor comprehension by working on an underlying mechanism (i.e., coarse semantic coding for metaphors).

While only one study specifically targeted nonliteral language in TBI participants, other pragmatic treatment programs incorporated nonliteral language into their sessions. This is the case of the Cognitive Pragmatic treatment (CPT; Bosco et al., 2018; Gabbatore et al., 2015; Parola et al., 2019; Sacco et al., 2016), which aims to improve communicative-pragmatic abilities through modules targeting several skills (e.g., conversational skills, inferential abilities, theory of mind, executive functions). Promisingly, the effectiveness of this program and the maintenance of gains were demonstrated using equivalent forms of a comprehensive communication assessment tool (ABaCo; Bosco et al., 2012; Sacco et al., 2008), narrative, and brain plasticity measures. Interestingly, one study (Bosco et al., 2018) showed a generalisation to functional communication abilities. More generally, these

programs also contribute to the recognition of pragmatic interventions as standard practice following TBI (Cicerone et al., 2019) and to the identification of best practices for the treatment of these disorders (see Togher et al., 2023 for a review of guidelines and evidence for cognitive-communication rehabilitation after TBI). On the other hand, the results reported on global measures (overall performance or scales of the ABaCo tool in the above-mentioned studies) drew no conclusions about the specific effectiveness of this program on irony and indirect request comprehension.

In summary, the existing studies, although few, provide encouraging results. They show that pragmatic skills can be improved following a TBI, with long-term maintenance of gains. They also underline the interest of treatments involving mechanisms and cognitive processes which are likely to participate in pragmatic understanding. However, only communicative-pragmatic abilities or metaphors have been remedied, leaving other nonliteral language forms – notably irony and indirect requests – without evidence of effectiveness. In addition, few studies have analysed the generalisation of gains into daily life, a crucial goal in speech and language therapy. These observations served as the starting point for our study, which aimed at assessing the effectiveness of therapy for irony and indirect request comprehension integrating the mechanisms likely to underlie this understanding (described below).

There is growing evidence suggesting that irony and indirect request comprehension relies on several mechanisms and cognitive processes (see Martin & McDonald, 2003; Pexman et al., 2019; Rowley et al., 2017 for reviews; Bosco et al., 2018; Cordonier et al., 2020). Three of them seem particularly important. Firstly, the integration of contextual information (e.g., contextual incongruity, speaker knowledge) seems to be essential for inferring the intended meaning of an utterance (e.g., Caffarra et al., 2019). Theory of mind, i.e., the ability to attribute intentions to others (Premack & Woodruff, 1978), may also be necessary to bridge the gap between literal and intentional meaning. Erroneous social inferences could thus lead to misinterpretations of a statement (e.g., understanding an ironic statement literally or laughing at a non-joking statement) (McDonald et al., 2017; Turkstra, 2008). Finally, executive functions, this set of high-level cognitive processes that enable us to adapt our behaviour in complex goal-oriented situations (Miyake et al., 2000), could help us to generate and inhibit intentions. In the case of preferential but inappropriate activation of the literal meaning, it has been intimated that executive functions are critical to the rejection of the irrelevant literal meaning and the generation of a more adequate alternative nonliteral meaning based on jointly manipulated, general and context-specific information. In agreement with pre-existing studies, effective therapy of irony and indirect request comprehension should therefore take into account these mechanisms and processes to maximise its effectiveness.

In a review, Pexman et al. (2019) emphasised the role of contextual information analysis in irony treatments. They identified five studies that have remedied irony comprehension in various study fields, including children, second-language learners, and people with autism. These studies (Bouton, 1999; Kim & Lantolf, 2018; Persicke et al., 2013; Saban-Bezalel & Mashal, 2015; Szücs & Babarczy, 2017) demonstrated that explicit metapragmatic training led to a significant improvement in irony comprehension. This training consisted of defining irony and its contextual cues and then putting them into practice in the context of written stories, comic strips, or videos. According to Bouton (1999), irony and indirect requests would be ideal candidates for explicit learning because their

understanding depends on cues that can be explicitly described and illustrated with various examples. However, to our knowledge, no study has applied this explicit metapragmatic approach to a TBI population.

Aims and hypotheses

The main objective of our study was to evaluate the effectiveness of a new therapy on irony and indirect request comprehension. This therapy was hybrid in format, combining explicit instructions of different forms of nonliteral language with written supports (nonliteral and literal stories) that allowed for practising the identification of these language forms. The treatment stages have also been designed to take into account the mechanisms possibly involved in nonliteral language comprehension (i.e., contextual processing, theory of mind, and executive functions). The therapy was administered to two participants with severe TBI. Indeed, single-case studies are valuable for analysing individual variability in treatment response, which is characteristic of the TBI population (Cordonier et al., 2020), and for testing a new treatment protocol prior to a larger-scale evaluation of its effectiveness (Cassel et al., 2020; Hsieh et al., 2012; Nickels et al., 2022).

Therefore, five specific objectives were pursued. Firstly, treatment effectiveness on the treated items (literal and nonliteral stories – objective 1) and the maintenance of gains one month after the end of the treatment (objective 2) were analysed. The generalisation of treatment gains to untreated items was also investigated directly after therapy and one month later (objective 3). Given the positive results shown in previous studies (Brownell et al., 2013; Lundgren et al., 2011; Pexman et al., 2019), we expected immediate gains on treated items, with the maintenance of gains one-month post-therapy and generalisation to untreated items. The fourth specific objective (objective 4) was to analyse the generalisation of treatment gains to more ecological situations and to the cognitive processes that may underlie the understanding of nonliteral language (i.e., theory of mind and executive functions). These two generalisation types have rarely been investigated in pragmatic disorder remediation studies. According to the systematic review by Cordonier (2017), gains from communication or prosody treatments tend to generalise to different measures of daily life. In contrast, generalisation to standardised metaphor and indirect request comprehension tests, or neuropsychological measures assessing executive functions and theory of mind, was not significant in several studies that treated metaphor comprehension (Blake et al., 2015; Brownell et al., 2013; Lundgren et al., 2011; Tompkins et al., 2012) or pragmatic-communication (Parola et al., 2019). Thus, we hypothesised a generalisation of the treatment gains to more ecological situations but an absence of generalisation to standardised tests assessing cognitive processes likely to underlie nonliteral comprehension. Finally, feedback from both participants was collected at the end of the therapy to assess their satisfaction with the therapy program (objective 5).

Method

Study design

The present study used a multiple-cases, multiple-baselines experimental design with an A-B-A type methodological protocol (see Figure 1). Given the length of the baseline

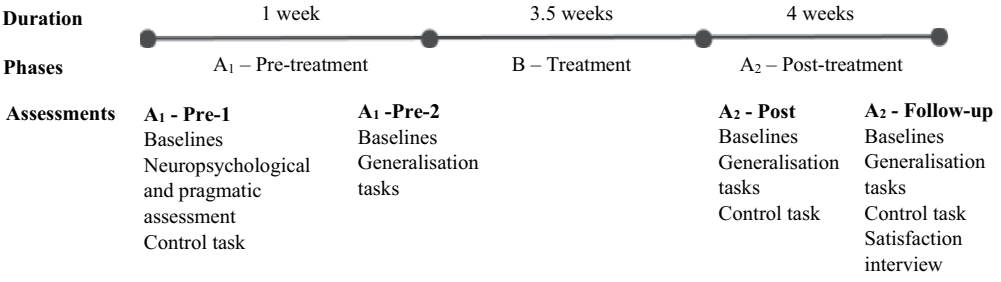

Figure 1. Study design *Note*. This study used an ABA design with three phases: Pre-treatment (A_1), including two assessments (Pre-1 and Pre-2 – baselines (twice), secondary measures, neuropsychological and pragmatic assessment, and control task); Treatment (B), comprising training with the explicit therapy using written stories; Post-treatment (A_2), including two assessments (Post and Follow-up – baselines, secondary measures, and control task).

administration, a cognitive psychology approach was adopted (Howard et al., 2015). This approach implied defining a predetermined number of measures in the pre-treatment (at least two) and post-treatment phases and not administering the baselines during therapy. Thus, the pre-treatment phase (A_1) lasted two weeks and included the administration of baselines on two occasions, one week apart, generalisation tasks on one occasion, and neuropsychological and language assessment. For each participant, the treatment phase (B) consisted of six or seven 45-minute sessions administered twice weekly for 3.5 weeks. Finally, the four-week post-treatment phase (A_2) included the assessment of baselines and generalisation tasks directly after therapy and one month later. To reinforce the methodological quality of our study, the person carrying out the assessment was not involved in the therapy phase and was blind to the stories used during treatment. The order of tasks and baseline stimuli was randomised. The reporting of the present study complies with the Single-Case Reporting guideline In Behavioural interventions (SCRIBE; Tate et al., 2016).

Participants

Participants were recruited between May 2020 and January 2022 through speech and language pathologists and neuropsychologists working in various hospitals in French-speaking Switzerland (HFR, RHNe, CHUV). To be included in the study, participants had to: (1) be of French mother tongue, right-handed, and between 20 and 65 years old; (2) have suffered, as an adult, a moderate to severe closed TBI; the time post-onset had to be greater than six months; (3) have disorders of nonliteral language comprehension (irony, indirect requests), objectified by a score below the 5th percentile on at least one irony or indirect request task of the "Protocole Montréal d'Évaluation de la Communication" (MEC; Joanette et al., 2004), or the Irony and Indirect Request comprehension test (IRRI; Cordonier et al., 2022) (see table 1). Participants were excluded if they had: (1) a history of psychiatric disorder affecting social cognition (according to DSM-V criteria), alcohol or drug dependence; (2) significant uncorrected vision and/or hearing impairment; (3) aphasia and/or significant reading and comprehension difficulties (i.e., score below the norm in language tests – see table 1); (4) an impaired capacity for judgment and

Table 1. Sociodemographic characteristics, neuropsychological and pragmatic data for both participants (P1 and P2)

	P1	P2
Sociodemographic characteristics		
Age (years)	42	51
Gender	M	M
Handedness	R	R
Education (years)	15	12
Time post-onset (months)	11	47
Neuropsychological data		
Language		
+ Global scale – DTLA (/100)	92	98
+ Spoken picture naming – Grémots (/36)	31	32
+ Oral comprehension of sentences – TICS (/12)	11	12
+ Written comprehension of sentences – TICS (/12)	12	12
Episodic/working memory		
Digit span forward	4**	7
Digit span backward	4	5
Corsi block-tapping test – Forward span	5	6
Rey Auditory Verbal Learning Test (RAVLT)		
Total recall (/75)	51*	48*
Recognition (/15)	15	13*
Delayed recall (/15)	11 + 1 intrusion *	10*
Rey–Osterrieth complex figure (RCFT)		
Immediate recall (/36)	22	15.5
Delayed recall (/36)	22	14
Semantic memory		
Pyramid and Palm Tree Test – pictures (/52)	48	48
Executive functions		
Verbal fluency		
Phonemic	16	12
Semantic	33	23
Trail Making Test		
Part A (sec)	34	41
Part B (sec)	78	104
Stroop Test		
Words (sec)	48	38
Colors (sec)	76	65
Interference (sec)	141	124
Social cognition		
Geneva Social Cognition Scale (GeSoCS)		
Social cognition (/20)	16**	18
Eyes emotion (/20)	18	18
Non-verbal ToM (/20)	17**	17**
Inferences (/20)	8**	18
Pragmatic data		
Narrative discourse – MEC-P		
Main ideas recall (/11)	6	9
Total comprehension (/16)	8**	14
Inference (/1)	0**	1
– Indirect speech acts comprehension – MEC (/40)	15**	36
Metaphor comprehension– MEC (/40)	31**	21**
– Irony comprehension – IRRI (/12)	5**	10**
– Hint comprehension – IRRI (/12)	6*	5**

Note. ** indicates a score below the norm (≥ 1.6 SD or below the 5th percentile); * indicates a score between the 6th and 16th percentile; + and – precede the tests used for inclusion and exclusion criteria, with + the tests to be preserved (scores > 16th percentile) and – the tests to be impaired (at least one performance < 5th percentile).

discernment, objectified by a neuropsychological evaluation or the establishment of a curatorship; (5) multiple TBI. These criteria were evaluated by the referring speech and language pathologists and neuropsychologists and then validated by the study authors.

Four participants met the criteria. However, two participants had to withdraw from the study for personal reasons (one before the start of the study, the other during the baseline evaluation). The sociodemographic characteristics and neuropsychological profiles of both remaining participants are presented in Table 1.

Case 1: P1

P1 is a 42-year-old right-handed man, trained as a building designer and carpenter (15 years of education), working as a carpenter at the time of his accident. He suffered polytrauma following a fall down a flight of stairs, which led to severe TBI with eleven weeks of post-traumatic amnesia and a Glasgow coma scale (GCS) score of 11/15. A brain scan showed right fronto-parieto-temporal lesions. P1 received neuropsychological therapy targeting attentional skills, fatigue management, and awareness of emotional and behavioural changes in a neurological rehabilitation centre for three months and continued as an outpatient for a further seven months. At the time of the study, he was 11 months post-TBI, was no longer receiving therapy, was living alone, and was independent in most daily activities.

Case 2: P2

P2 is a 51-year-old right-handed man. He was trained and working as a forester (12 years of education) at the time of his accident. He suffered a severe TBI after a paragliding accident with four weeks of post-traumatic amnesia and a GCS of 11/15. Brain imaging showed an open right temporoparietal fracture and a right epidural hematoma, with a left and right frontoparietal punctiform haemorrhagic contusion. He received neuropsychological therapy targeting attentional skills, facial emotion recognition, and awareness of emotional and behavioural changes in a neurorehabilitation centre for two months and then as an outpatient for nine months. At the time of the study, he was 47 months post-TBI, was no longer receiving therapy, was living with his children and was independent in most daily activities.

General neuropsychological and pragmatic assessment

To check the inclusion criteria and to establish a general cognitive profile, the participants were assessed using standardised language and neuropsychological tests: the "Detection Test for Language Impairments in Adults and the Aged" (DTLA; Macoir et al., 2017), Grémots battery (Bézy et al., 2016) and "Test informatisé de compréhension syntaxique" (TICS; Python et al., 2013) for language; the backward and forward Digit Span subtests (Wechsler, 1981), the Corsi block-tapping test (Corsi, 1972), the Rey Auditory Verbal Learning Test (RAVLT; Schmidt, 1996), the Rey Complex Figure Test (RCFT; Meyers & Meyers, 1995) and the Pyramids and Palm Trees test (PPTT; Howard & Patterson, 1992) for memory; the phonemic and categorical verbal fluency test (Cardebat et al., 1990), the Trail Making Test (Reitan & Wolfson, 1993), and the Stroop test (Stroop, 1935) for executive functions; and the Geneva Social Cognition Scale (GeSoCS; Martory et al., 2015) for social cognition. Pragmatic skills, and in particular the comprehension of nonliteral language, were assessed using the MEC protocol (Joanette et al., 2004) and a short version of the IRRI

test (Cordonier et al., 2022) (see Table 1). When these tests had been administered in previous neuropsychological or language examinations carried out up to six months before the start of the study, performance was collected to avoid a learning effect by re-administering them. If not done previously, tests were completed during the first session of the study (see Figure 1).

These assessments confirmed pragmatic disorders, especially difficulties in understanding nonliteral language (indirect requests, irony, and metaphors) in both participants (see Table 1 – MEC and IRRI tasks' results). These disorders co-occurred with impaired social cognition (GeSoCS) and verbal short-term memory (Digit span forward) in participant P1 and with theory of mind (GeSoCS – Non-verbal ToM) and mild verbal episodic memory deficits (RAVLT) in participant P2 (see Table 1). The other cognitive dimensions were globally preserved.

Context and ethical approvals

For P1, the baselines and generalisation tasks assessments (phases A_1 and A_2) were conducted in a hospital and the treatment sessions (phase B) at the participant's home. For P2, all phases were conducted at the participant's home.

The study was approved by the Cantonal Human Research Ethics Commission (CER-Vaud; Project ID: 2020-00301) and registered on the ClinicalTrials.gov system (ID: NCT04708561). All participants meeting the inclusion criteria were informed about the study by their neuropsychologist or speech and language pathologist. They were given two weeks of reflection. To help them make an informed decision about participating in the study, clear explanations about the study were provided, and an information sheet was given to them. If they agreed, a first meeting with the investigator was organised. The study was again explained, and the consent form was discussed and signed before beginning the first assessment.

Measures and material

Several tasks were used to measure treatment effectiveness in terms of immediate gains, maintenance of gains, generalisation to untreated items, ecological situations, and the cognitive processes that may underlie nonliteral language comprehension. These tasks differed from those administered in the neuropsychological and pragmatic assessments (see Table 1). They were either created to best suit the experimental design of our therapy or chosen from existing standardised tests that demonstrated good psychometric quality (notably the absence of a test-retest effect) and relevance to our therapy.

Primary outcome measure (baselines) - Written intention task

A written intention attribution task was used as the primary measure of the study to assess the treatment effectiveness in immediate gains, maintenance of gains, and generalisation to untreated items. The rationale behind choosing such a task was the inferential dimension inherent in understanding irony and indirect requests. In addition, this task allowed us to mix the nonliteral intentions with competing communicative intentions. The written format was justified by the greater control it offers over relevant parameters (e.g., cues, complexity), its lower load on working memory

and its representativeness in our daily lives (Whalen et al., 2009). Thus, the task included 50 stories, each ending with a statement that could be interpreted literally, ironically, as an unconventional indirect request, a lie, or a faux pas (see supplementary material for examples). These communicative intentions were chosen to illustrate contrasts between explicit and implicit meaning (i.e., literal versus nonliteral), intentionality and non-intentionality (i.e., nonliteral versus faux pas), and shared or unshared knowledge between speakers (i.e., irony versus lie). All stories were drawn from existing French language protocols (Achim et al., 2012; Bertoux, 2014; Bossut, 2011; Corcoran et al., 1995; Cordonier et al., 2022; Gaudreau et al., 2013; Joanette et al., 2004; Sonrier & Vanberten, 2015; Spotorno et al., 2012) and were presented on a computer screen. The participants were asked to read the stories silently and answer orally to questions such as "What does X (the speaker) mean?" about the character's last utterance. In the faux pas stories, the question, "Did someone say something awkward or that they should not have said?" was asked.

Secondary outcome measures – Generalisation tasks

The present study analysed two types of generalisation: generalisation to more ecological situations and tasks assessing cognitive processes of interest (i.e., theory of mind and executive functions).

Generalisation to more ecological situations. The generalisation to more ecological situations was assessed by a new dynamic intention attribution task and two questionnaires. This task included 16 short video clips from famous TV shows that ended with a statement with a similar communicative intent as the written intention attribution task (i.e., literal, ironic, unconventional indirect request, lie, and faux pas). After each video, a question on the character's statement was asked ("What does X (the speaker) mean?" or "Did someone say something awkward or that they should not have said?"). The responses were recorded, transcribed, and scored as 0, 1, or 2 based on the accuracy of the response (see supplementary material for a precise description of the scoring). A pilot study with 17 healthy subjects allowed us to select the 16 most understandable and relevant excerpts from 26 video excerpts (average percentage of success of the 16 excerpts: 84.56%; SD: 8.52).

Two questionnaires were also addressed to the participant and their close family. To the best of our knowledge, no pragmatic questionnaire can accurately assess the impact of nonliteral language comprehension disorders on daily life. We, therefore, opted for social cognition and theory of mind questionnaires (ERF-CS, Peyroux & Franck, 2014; Theory of mind questionnaire from Taché, 2014), given the close relationship between pragmatics and theory of mind and the presence of specific questions to nonliteral language in these questionnaires. The ERF-CS, administered to the participant, consisted of 14 questions assessing four domains of social cognition: theory of mind, emotional processes, attributional style and social knowledge. The theory of mind questionnaire (Taché, 2014) was administered to a close relative chosen by the participant (i.e. the parents of P1 and a child of P2). It consisted of 24 questions designed to assess three areas: social participation, conversation management and perspective-taking.

Tasks for generalisation to cognitive processes likely to underlie nonliteral language comprehension. As the treatment took into account theory of mind and executive functions, standard neuropsychological tests assessing these constructs were integrated into the assessment to examine generalisation to these cognitive processes of interest. Theory of mind was thus measured by the TOM-15 first- and second-order false belief test (Desgranges et al., 2012). Executive functions were assessed with the Hayling Test (Rouleau, 1998) for inhibition, alternate fluency (D-KEFS – Delis-Kaplan Executive Function System; Delis et al., 2001) for flexibility and the PASAT-R (Naegele et al., 2004) for working memory.

Control task

A control task was included in the study to ensure that any improvement was due to the treatment itself and not to nonspecific aspects of the treatment (i.e., an effect of simply being present or engaged in any activity with the patient) or to spontaneous recovery (Howard & Hatfield, 2018). The control task assessed a cognitive dimension which was not involved in therapy but deficient in the participant according to previous neuropsychological assessments: the written calculation subtest of the TLC-2 (Test Lillois de Calcul 2; Bout-Forestier et al., 2008; dependent variable: score) for P1 and a mental rotation task (Verdon & Hauert, 2005; dependent variable: execution time in seconds) for P2.

Satisfaction interview

A satisfaction interview (see supplementary material) was created to collect participant feedback about the therapy in general, the possible positive effects of the therapy and the treatment modalities (intensity, activities).

Procedure

Phase A1: Pre-treatment

The pre-treatment phase included two assessments (Pre-1 and Pre-2), covering baselines, secondary outcome measures, control task, neuropsychological and pragmatic examination (see Figure 1). The baselines consisted of the written intention attribution task described above. The 50 stories were administered in two sessions spaced one week apart (pre-1 and pre-2). To control for a possible order or fatigue effect, the order of the stories was randomised between the two assessment sessions. Responses were recorded, transcribed, and then rated as 0, 1, or 2 according to the instructions given by each story author. Twenty-five percent of the data set was scored at the end of the therapy by a person who was blind to the completion time (pre-, post-, or maintenance). The interrater reliability (Cohen's Kappa) was good, P1: K = .687, p < .0001; P2: K = .779, $p <$ .001. From the performance of P1 and P2 on the two baseline measures, two equivalent therapy lists were created: a treated list and an untreated list. The stories in each list were rigorously matched in terms of baseline performance, average story length (number of words) and type of intent (ironic, indirect request, lie, faux pas, and literal). Those with the highest scores in both administrations were excluded. This careful allocation resulted in two lists of 18 stories each for P1 and 16 stories each for P2. These two lists were then compared (Mann-Whitney) to confirm the absence of difference in the above parameters. Results showed no significant difference in performance at each baseline in either pre-

treatment sessions, P1: pre-1: U = 166.5, p > .05; pre-2: U = 177.5, p > .05; P2: pre-1: U = 123.5, p > .05; pre-2: U = 120.5, p > .05, and for average story length, P1: U = 152, $p > .05$; P2: U = 127, $p > .05$; min: 20 words; max: 218 words. The type of intentions was also similar between both lists (P1: six ironies, six indirect requests, two lies, two faux pas, two literals and one no faux pas per list; P2: seven ironies, five indirect requests, two lies, one faux pas, one literal and one no faux pas per list).

The neuropsychological and pragmatic assessment, the generalisation tasks, and the control tasks described above were also administered once during the pre-treatment phase.

Phase B: Treatment

The treatment consisted of seven (participant P1) and six (participant P2) sessions spread over 3.5 weeks, with two 45-minute sessions per week. The sessions were conducted in the participants' homes. A hybrid approach, which combined explicit instructions of nonliteral language forms and written supports, allowing for practising nonliteral statement identification in relation to the mechanisms likely to underlie their comprehension, was adopted.

The first session aimed to introduce the idea of polysemous communication through a concrete example. The sentence "the room is full of people" was used to illustrate and make explicit the possible interpretations (i.e., literal, ironic, indirect request, lie, and faux pas) according to the context. A framework summarising the characteristics of each interpretation was then given to the participant (see supplementary material for details of the first session and framework). The modalities of therapy were then discussed.

The following sessions were devoted to the treated list stories (three stories per 30-45 minute session) and to relating them to everyday situations (see Figure 2). In concrete terms, each story was worked on in three successive steps using a PowerPoint presentation. In step 1, the target statement of the story was presented in isolation to the participant. Using the framework given in the first session, the participant was asked to choose at least three possible interpretations for this statement and imagine associated contexts. For the example in Figure 2, the participant could thus evoke irony and imagine a context where two new students have difficulty finding the cafeteria at their new school. Questions about the characters' communicative intentions and mental states (e.g., Why would he be ironic? How might the other student feel?) were also posed to put theory of mind more into play. In the second step, only the context of the story was shown to the participant, who then had to identify the critical elements. This second stage aimed to work on contextual integration and the inhibition of irrelevant information. The participant was asked to mention various elements reported in the context (e.g., characters, place, environment, activities) and to justify the relevance of these elements. The therapist wrote a summary of the most relevant elements (e.g., the 30-minute search by the two characters in the example in Figure 2) at the end of the analysis. Finally (step 3), the participant discovered the whole story. The participant was then asked to judge the likelihood of the interpretations generated in the first step on a Likert scale ranging from 1 (very unlikely) to 4 (very likely). This probability judgment had to be justified using the contextual elements identified in the second step. Thus, the evocation of irony in the example of Figure 2 would be expected to be judged as very likely and justified by the 30 minutes of research experienced by the two participants.

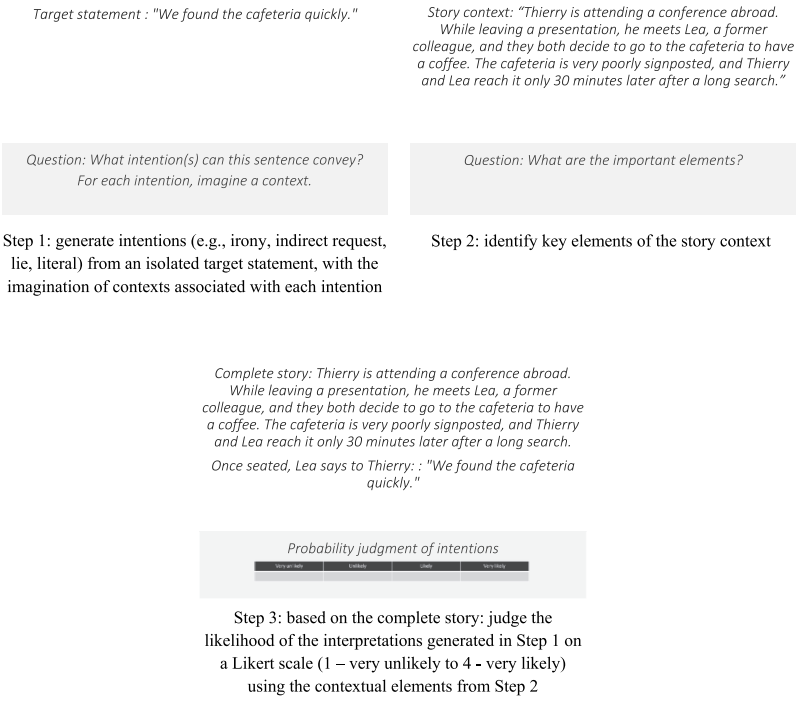

Figure 2. Example of a story with the treatment steps

At each step, immediate feedback was given in the form of positive verbal reinforcement for correct answers (e.g., "Yes, that's correct" + repetition of relevant response elements) and immediate corrective feedback in the form of guiding questions in case of difficulty. Throughout the session, connections to real-life situations were encouraged by questions at the end of each treated story (e.g. "Does this irony reminds you of a situation in your daily life?"). The length of the stories increased over the sessions to gradually increase the working memory load.

Phase A2: Post-treatment

The post-treatment phase included two assessments (Post and Follow up) to assess any immediate gains from therapy and their maintenance. The treated and untreated lists (baselines), the generalisation tasks, and the control tasks were thus repeated two days after the last session and then administered again one month later. It should be noted that data from the participant P1 questionnaires could not be collected at the follow-up assessment. A satisfaction interview was also administered in the follow-up session by a different person from the therapist.

Data analysis

The accuracy of the treated and untreated lists of the written intention attribution task was analysed using WEighted STatistics (WEST; Howard et al., 2015). The score obtained on each item in each assessment was multiplied by a weighting coefficient, that was calculated based

on the number of assessments performed in the pre- and post-treatment phases. Weights for each analysis were obtained using spreadsheet calculations, forwarded by Howard et al. (2015; personal communication), and are reported in Appendix 2. The resulting weighted scores were then added up to form a single score per assessment, thus avoiding autocorrelation bias. One-tailed t-tests were used to compare these single scores at various phases of treatment. A significance level at $p < .05$ was considered for all WEST analyses.

Treatment efficacy (objective 1) was measured using the WEST-ROC and WEST-Trend analyses. The WEST-ROC (WEST-Rate of Change) analysis compared the rate of change between the periods with and without treatment. The WEST-Trend analysis provided additional information regarding the existence of a linear trend of improvement. Therefore, treatment efficacy could only be determined if both the WEST-ROC and WEST-Trend analyses were significant.

Maintenance of treatment gains at one-month (objective 2) was assessed using the WEST-COL (WEST-Compare Level of performance) statistics. These analyses were designed to compare the level of performance of the treated list between the maintenance assessment and the average of the two pre-treatment assessments on the one hand and between the maintenance and post-treatment assessments on the other. Since these statistics can only be used in the case of stable performance in the pre-treatment phase, Wilcoxon tests were performed to compare performances at the two pre-treatment assessments. The statistically non-significant difference attested to stable performance, P1: $Z = .655$, $p > .05$; P2: $Z = .447$, $p > .05$.

To explore the generalisation of treatment effects to untreated items (objective 3), the analyses described above (WEST-ROC, WEST-Trend, WEST-COL) were replicated on the untreated list. The stability of performance in the pre-treatment phase for the untreated list, P1: $Z = .739$, $p > .05$; P2: $Z = .816$, $p > .05$, necessary for the WEST-COL statistics, was also demonstrated.

A qualitative analysis was also performed on the data from each intention of the written intention attribution task to analyse, more specifically, the progression of irony and indirect request comprehension.

The generalisation to more ecological situations and the cognitive processes of interest (theory of mind and executive functions) (objective 4) was examined using Q' tests (Michael, 2007), comparing performance on generalisation measures across the three phases of treatment (pre-treatment, post-treatment, and follow-up assessments). As the Q' test may be used to test the hypothesis of equal or different proportions only in a $2 \times K$ design (comparison of K tests in two phases), the three treatment phases in the present study were compared in a binary way for each test, with a significance level set at $p < .017$ according to the Bonferroni correction.

Finally, the feedback from the satisfaction interviews (objective 5) was transcribed and analysed qualitatively.

Results

Primary outcome measure - Written intention task

The performance of P1 and P2 on the treated and untreated lists during the three treatment phases (A_1 – Pre-treatment, B – Treatment, and A_2 – Post-treatment) is reported in Figure 3.

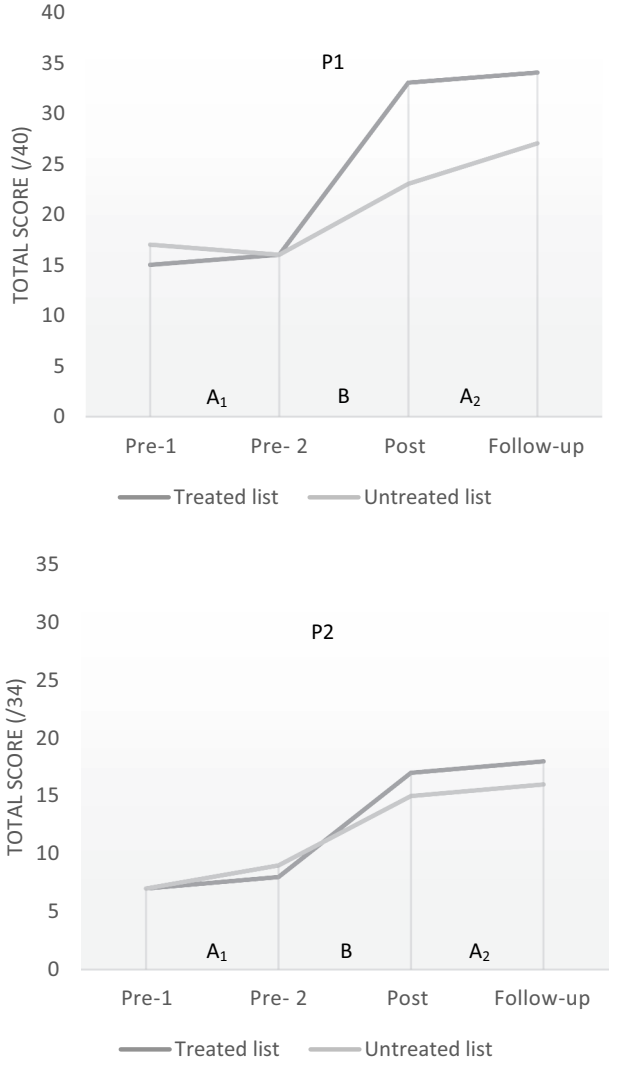

Figure 3. Performance of participants P1 and P2 on both lists (treated, untreated) during the three treatment phases (A_1 pre-treatment, B treatment and A_2 post-treatment)

Treatment effectiveness for treated items

Analyses to assess immediate gains for the treated list showed, for P1, a greater rate of change during the treatment phase (B) compared with the no-treatment phases (A_1 and A_2), $t(18) = 3.51$, $p_{\text{WEST-ROC}} < .002$, and a linear trend toward improved performance for the treated list across the study, $t(18) = 5.66$, $p_{\text{WEST-Trend}} < .0001$. For P2, the rate of change during the treatment (B) phase compared with the no-treatment phases (A_1 and A_2) was not significant, $t(16) = 1.33$, $p_{\text{WEST-ROC}} > .05$, but there was a linear trend toward improved performance for the treated list across the study, $t(16) = 2.98$, $p_{\text{WEST-Trend}} < .005$.

Maintenance of treatment gains at one month for treated items

Maintenance analyses showed that, for both participants, performance on the treated list one month after therapy was significantly better than in pre-treatment, P1: $t(18) = 5.37$, $p_{WEST\text{-}COL} < .0001$; P2: $t(16) = 2.74$, $p_{WEST\text{-}COL} < .008$, but relatively stable compared to post-treatment performance, P1: $t(18) = .44$, $p_{WEST\text{-}COL} > .05$; P2: $t(16) = .27$, $p_{WEST\text{-}COL} > .05$.

Generalisation to untreated items

Analyses to assess immediate gains on the untreated list showed, for both participants, a linear trend toward improvement, P1: $t(18) = 4.72$, $p_{WEST\text{-}Trend} < .0001$; P2: $t(16) = 3.03$, $p_{WEST\text{-}Trend} < .005$, but a rate of change that was not statistically significant between the treated (B) and untreated (A_1 and A_2) phases, P1: $t(18) = -.63$, $p_{WEST\text{-}ROC} > .05$; P2: $t(16) = .79$, $p_{WEST\text{-}ROC} > .05$.

Regarding the maintenance analyses, results showed that P1's performance on the untreated list was significantly better one month after therapy than in the pre-treatment, $t(18) = 4.53$, $p_{WEST\text{-}COL} < .0002$, and post-treatment assessments, $t(18) = 2.36$, $p_{WEST\text{-}COL} < .015$. P2's performance one month after the end of the treatment was significantly better than his performance at the pre-treatment assessment, $t(16) = 2.79$, $p_{WEST\text{-}COL} < .007$, but relatively stable compared to his post-treatment performance, $t(16) = .29$, $p_{WEST\text{-}COL} > .05$.

Qualitative analysis

Participant scores for each communicative intent are detailed in Table 2. Both participants showed a trend of improvement for treated ironic and indirect request stories between the pre- and post-treatment assessments, with one-month maintenance. Improvement was also observed for the untreated ironic and indirect request items. However, this improvement seems slightly weaker, observable only in the longer term for irony for P1 and with more fragile maintenance (indirect requests for P2 and irony for P1). The other intentions also showed a positive evolution, although slightly less consistent.

Secondary outcome measures – Generalisation tasks

The results for P1 and P2 on the generalisation and control tasks at each phase of treatment are reported in Table 3. For P1, no significant differences between treatment phases were found in measures assessing generalisation to more ecological situations and cognitive processes likely to underlie nonliteral language comprehension. However, a marginally significant difference was observed in the follow-up (versus pre-treatment) assessment for the video intention attribution task. The Q' test could not be used to analyse performance on the alternate fluency task, as a maximum score could not be defined. However, P1's performance on this task was found to be within the norm in all assessments. In addition, scores on the control task were stable across the three treatment phases.

For P2, a significant improvement between the pre-treatment and follow-up assessments was observed on the PASAT task. No other significant differences were found in the ecological, theory of mind, and executive tasks. Performance on the alternate fluency task was within the norm on all assessments. Scores on the control task were stable, with performance below the norm in all assessments.

Table 2. Correct answers for each communicative intention in the written intention task for the two lists (treated, untreated) in the four assessment sessions for both participants (P1 and P2)

Intention	List	Assessments							
		P1				P2			
		Pre-1	Pre-2	Post	FU	Pre-1	Pre-2	Post	FU
Irony (/12; /14)	Treated list	4	3	**9**	**9**	4	4	**7**	**6**
	Untreated list	5	6	5	**9**	2	2	**6**	**3**
Indirect requests (/12; /10)	Treated list	5	8	**11**	**12**	1	1	**6**	**5**
	Untreated list	4	6	**9**	6	2	2	**5**	**5**
Lies (/4; /4)	Treated list	3	3	3	3	1	1	**2**	1
	Untreated list	3	2	**4**	3	0	1	1	**2**
Faux pas (/6; /2)	Treated list	3	2	**6**	**5**	1	2	2	2
	Untreated list	3	2	2	3	1	0	1	**2**
Literal (/4; /2)	Treated list	0	0	**2**	**3**	0	0	0	**2**
	Untreated list	2	0	**3**	**4**	2	2	2	2
No faux pas (/2; /2)	Treated list	0	0	**2**	**2**	0	0	0	**2**
	Untreated list	0	0	0	**2**	0	2	0	2
Total (/40; /34)	Treated list	15	16	33	34	7	8	17	18
	Untreated list	17	16	23	27	7	9	15	16

Note. Bold font indicates an improvement over the pre-treatment assessments; FU = one-month follow-up

Satisfaction interview

On a Likert scale, both participants showed a very high level of satisfaction with the therapy (5/5). The duration and frequency of the sessions (twice a week for one month) were considered ideal. Participant P1 emphasised the interest of the links with daily life and the important involvement of attentional skills (i.e., concentration) in the therapy. Participant P2 highlighted the novelty of the proposed exercises. Criticism focused on the repetitive and time-consuming nature of the baselines, and on the changes observed as a result of the therapy.

Discussion

The present study aimed to assess the efficacy of a therapy targeting irony and indirect request comprehension in two individuals with severe TBI. The therapy was administered in two weekly sessions for 3.5 weeks. It combined the explicit instruction of different communicative intentions and practice within written stories with an engagement of the mechanisms possibly involved in nonliteral language comprehension. Multiple baselines (treated and untreated lists), a control measure, and measures of generalisation to more ecological situations and cognitive processes of interest (i.e., theory of mind and executive functions) were administered pre-therapy, post-therapy, and one month later to analyse the effectiveness of the therapy in terms of immediate gains, maintenance of gains, and generalisation. An interview was also conducted one-month post-treatment to assess participant satisfaction with the treatment.

Regarding our first objective (treatment effectiveness on the treated items), both participants showed an improvement in the treated stories, especially for irony and indirect requests. These results confirm previous studies that have shown that explicit training could improve irony comprehension in people with autism spectrum disorder (Persicke et al., 2013; Saban-Bezalel & Mashal, 2015). Our study yet extends these findings for the first time to irony and indirect requests comprehension in individuals with TBI.

Table 3. Results on generalisation measures in ecological situations, cognitive processes likely to underlie nonliteral language comprehension, and the control task during the three treatment phases for both participants (P1 and P2)

	P1						P2					
Test	Pre	Post	FU	Pre vs post *p*-value	Pre vs FU *p*-value	Post vs FU *p*-value	Pre	Post	FU	Pre vs post *p*-value	Pre vs FU *p*-value	Post vs FU *p*-value
Ecological generalisation												
Video – total (/37)	22	30	32	.0807	**.0234**	.6027	25	26	23	.8318	.6795	.5314
Questionnaires:			-									
ERF-CS (/140)	42	43	-	.9147	-	-	0	0	0	1	1	1
Theory of mind (/96)	57	58		.9028	-	-	49	58	58	.2765	.2765	1
Cognitive processes												
Hayling inhibition (/16)	6	6	7	1	.7482	.7482	7	7	6	1	.7482	.7482
Alternate fluency	13	14	15	-	-	-	12	16	15	-	-	-
PASAT-R (/60)	42	46	46	.4913	.4913	1	39	50	53	.0531	**.0103**	.5207
TOM-15 1st order (/8)	8	8	8	1	1	1	8	8	8	1	1	1
TOM-15 2nd order (/7)	5	6	6	.5483	.4583	1	5	6	7	.5483	.1795	.4483
Control task												
TLC-2 (/12)	7	7	8	1	.7004	.7004						
Mental rotation (time, sec.)							42	44	41	-	-	-

Note. Bold font indicates significant difference; FU = one-month follow-up.

However, it should be noted that while a linear trend of improvement was significant in both participants, only one participant (P1) demonstrated a significant rate of change. According to Howard et al. (2015), treatment efficacy can only be concluded if both the linear trend of improvement (WEST-Trend) and the rate of change (WEST-ROC) are significant. WEST statistics are of interest and have been used in a growing number of studies (e.g., Creet et al., 2019; Croot et al., 2019) because of their consideration of possible baseline evolution, their application to studies without continuous measurements during treatment, and their minimisation of autocorrelation problems. For a few researchers (Beeson, 2015; Johnson & Kiran, 2015), however, WEST statistics also have some limitations: they would be best suited for studies that include a large number of items and a limited number of assessments, similarly spaced over time. In our study, the number of stimuli was limited because of the administration time. Moreover, due to the unequal time between assessments in our study, the weights had to be adjusted.

Our second hypothesis (maintenance of gains) is also confirmed since our results showed that the performance of our two participants one month after therapy was significantly better than in pre-treatment and stable with regard to the end of treatment. Our study thus corroborates the maintenance of treatment gains demonstrated in other studies on metaphor comprehension or communication-pragmatic abilities (Brownell et al., 2013; Gabbatore et al., 2015; Sacco et al., 2016).

Regarding the generalisation of treatment gains to untreated items (objective 3), our results showed a linear trend towards improvement in both participants and a better performance one month after therapy than in the pre-treatment assessments. The modality of our therapy may explain this generalisation to untreated items. Indeed, our therapy aimed to encourage strategies for recognising irony and indirect requests that can be internalized and applied to other stimuli. For example, we taught participants to identify a contrast between statement and context, as well as the shared knowledge of interlocutors to understand irony (see Figure 2 and supplementary material). This identification can then be applied to a variety of everyday situations. It also provided flexibility in patient responses and clinician feedback and allowed for the inclusion of a sufficient number of items. These factors are likely to promote the generalisation of treatment gains to untreated items (see Coppens & Patterson, 2017; Tompkins & Scott, 2013).

Interestingly, while stability in performance between the post-treatment and one-month follow-up assessments was observed in participant P2, participant P1 continued to improve between these two assessments. According to Coppens and Patterson (2017), an improvement on treated and untreated items may rely on various neurological processes related to specific learning mechanisms. For example, Vitali and colleagues (2010) reported in two individuals with chronic aphasic a generalisation of gains from phonological anomia treatment to untreated items only in the six-month follow-up measures. Directly after therapy, functional connectivity associated with untreated items was increased in different brain networks, more so in the right hemisphere, compared with those activated for treated items. At the follow-up assessment, the functional connectivity of the untreated items shifted in the direction of the networks activated for the treated items. The researchers concluded that this pattern of evolution reflected a progressive ability of participants to apply phonological strategies to untreated items, resulting in the increased activation of more efficient brain networks at the follow-up assessment. A similar conclusion can be applied to participant P1. The one-

month break between post-treatment and follow-up assessments may have been favourable for the assimilation of strategies trained in therapy, allowing for better application to untreated items at the follow-up testing. The low intensity of the treatment (two weekly sessions) in our study may also have contributed to this increasing improvement in untreated items at follow-up assessment (Sage et al., 2011). Indeed, according to the cognitive psychology, non-intensive distributed practice would promote deeper encoding through the mental rehearsal between therapy sessions and assessments (Dignam et al., 2016). A follow-up assessment would be more likely to reflect this encoding than the priming effect through repetition, visible especially in post-treatment assessment on treated items.

Our fourth objective was to analyse the generalisation of treatment gains to more ecological situations and cognitive processes that may underlie nonliteral language comprehension (i.e., theory of mind and executive functions). Overall, we obtained mixed results. On ecological measures, encouraging results were obtained on an analogous video intention attribution task, with continued improvement and a marginally significant difference in the follow-up assessment compared with pre-treatment assessments for P1. These results again suggest that the low intensity of the treatment and a period without treatment may be beneficial for the progressive assimilation of trained strategies and their application to untreated situations. In contrast, participant P2 did not show a significant change in the video task, and the questionnaire results were not significant for either participant. These results may be explained primarily by the duration of therapy and the one-month delay in the follow-up assessment. In a systematic review of interventions targeting social communication, Finch and colleagues (2016) reported that the most robust evidence of effectiveness was obtained in studies that administered "contextualised treatment" (Ylvisaker et al., 2002) for a minimum of ten weeks.

For the cognitive processes tasks, as expected, performance on theory of mind and executive tests did not show significant change for the most part. These results are consistent with previous studies of speech and pragmatics remediation, which did not find generalisation to standardized executive or theory of mind measures (Brownell et al., 2013; Lundgren et al., 2011; Marangolo et al., 2013; Parola et al., 2019). Surprisingly, a positive change in the follow-up assessment was observed in participant P2 for the PASAT working memory task. This result does not appear to be related to a practice effect, as the test has good test-retest reliability (Ting-Jia et al., 2022). Conversely, our therapy format, consisting of stories of varying length and complexity, may have contributed to this result. Indeed, several authors (Blake, 2007; Tompkins, 2012) have suggested that such a manipulation would be indicated for patients with limited cognitive resources, such as our participant P2. On the other hand, our therapy format may not have sufficiently challenged inhibition, flexibility, and theory of mind abilities. Indeed, we assumed that these skills were implemented in therapy through the generation of different communicative intentions, some of which were irrelevant and needed to be inhibited. More specific modules on executive skills and theory of mind, as proposed in some communicative-pragmatic programs (Gabbatore et al., 2015), might better promote generalisation to these cognitive processes. It is also possible that the standardised tests chosen to measure this generalisation were not sufficiently sensitive to quantify treatment-induced improvement (Seron, 2014). Replication of the treatment with more patients and different generalisation measures is needed to confirm these hypotheses.

Importantly, it would be challenging to explain the improvements in both participants in terms of spontaneous recovery. Indeed, both participants were in a chronic stage. Moreover, performances on a control task (written operations - TLC2 and mental rotation) were stable throughout the study. These results support the targeted effectiveness of the therapy developed in this study.

Finally, the therapy fulfils an essential subjective criterion: patient satisfaction (objective 5). An interview conducted at the end of the therapy, not by the therapist, showed a high satisfaction level in P1 and P2 concerning the therapy in general, its modality, and its duration. The limitations reported by participants (baseline redundancy and generalisation to daily life) corroborate our observations and re-emphasise the value of shorter baselines and a longer duration of therapy with longer term follow-up assessments.

Limitations

Several limitations of the present study can be noted. Firstly, the sample size is small. Unfortunately, only two of the four enrolled participants were able to complete the entire treatment. The replication of the therapy with a larger number of participants, possibly with different aetiologies, would increase the study's external validity. However, despite this small sample size, the results uniformly tend toward the effectiveness of our therapy, not explicable by spontaneous recovery or nonspecific aspects of the treatment. A second limitation is the scope of generalisation to everyday life. This limitation can be linked to the duration of the therapy, determined on the basis of the number of failed stimuli to be worked on in a session. The written modality of our therapy, although justified (better control of parameters, reduced load on working memory, representativeness of our daily life), may also have limited generalisation to oral situations. Finally, it is possible that the questionnaires targeting social cognition were not sensitive enough to show pragmatic changes in daily life. A third limitation is the non-continuous assessment of baselines during therapy, that is necessary to meet the methodological rigor of single-case experimental design (Tate et al., 2008). However, to the extent that this assessment was time-consuming and fatiguing for participants, adopting a cognitive psychology approach seemed to us to be the best option.

Future development

The present study represents an important first step, underscoring the relevance and feasibility of our therapy for improving nonliteral language comprehension while also highlighting points of improvement for replications of the therapy. Our future protocol could thus include more and shorter stimuli and a similar period between assessments. A longer duration of therapy, with follow-up assessments at three and six months, could also be indicated. The exact duration could correspond to a compromise between the ten weeks recommended by (Ylvisaker et al., 2002) and the 3.5 weeks appreciated by participants or be determined by a success rate rather than a pre-defined number of sessions (Howard et al., 2015). In addition, group sessions and executive functions/theory of mind modules could be added to the individual therapy program (Cummings, 2009; Tompkins & Scott, 2013). These sessions would extend the duration of therapy and introduce non-

written material (e.g., video analysis, role-playing, sharing of experiences in the group sessions; Gabbatore et al., 2015), which could be conducive to generalisation. Finally, it would also be interesting to pay particular attention to participant self-awareness of their disorders, which could influence the results of the self-report questionnaires (Steward & Kretzmer, 2021). These replications of the present therapy will have the potential to specify the "active ingredients" that we assume contribute to successful therapy, namely: therapy taking into account underlying mechanisms, with numerous items, step-by-step work, targeted feedback and reinforcement; exercises in various formats to encourage generalisation; low treatment intensity; preserved awareness of disorders (Dijkers et al., 2014).

Applicability

The results of the present study add to the sparse but relatively robust evidence regarding the relevance of explicit therapies (Pexman et al., 2019) or therapies targeting an underlying mechanism (Brownell et al., 2013; Lundgren et al., 2011; Tompkins et al., 2012) to improve nonliteral language comprehension in various pathologies. In addition, the current therapy has major clinical potential due to its positive results and ease of administration. The individual modality of the therapy allows immediate treatment of any patient with nonliteral language comprehension deficits. The equipment and the procedure are easily adaptable to the specific interests and disorders of each patient. Finally, the experimental design, integrating known and accessible measures for clinicians, promotes its replicability in the clinic.

Conclusion

In conclusion, the present study contributes to filling a critical gap in evidence related to the remediation of nonliteral language comprehension in the TBI population. Through a multiple-cases, multiple-baselines experimental design, our study demonstrated that it is possible to improve irony and indirect request comprehension following a TBI, with potential generalisation to untreated items and more ecological situations. The results of the treatment and the participants' feedback also provide interesting points of improvement for replications of the therapy. Finally, on a clinical level, our study offers concrete therapeutic avenues.

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Disclosure statement

The authors report there are no competing interests to declare.

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ORCID

Natacha Cordonier http://orcid.org/0000-0002-2991-6317
Maud Champagne-Lavau http://orcid.org/0000-0003-4659-6957
Marion Fossard http://orcid.org/0000-0002-4955-2354

Data availability

The datasets generated using and/or analysed during the current study are available from the corresponding author on reasonable request.

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