

The impact of the Cognitive Pragmatic Treatment on the pragmatic and informative skills of individuals with traumatic brain injury (TBI)



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ABSTRACT

Objective: Pragmatic impairment and narrative difficulties commonly affect individuals after traumatic brain injury (TBI). Rehabilitative programs may improve such impaired capacities and promote social recovery. Cognitive Pragmatic treatment (CPT) is a rehabilitative group program that encompasses different communicative skills, including sessions dedicated to the ability to structure a discourse with an adequate amount of information and relevant contents. This study aims to determine the efficacy of the CPT program in improving informative skills during narrative production. We also investigated the impact of CPT on some of the patients' cognitive abilities that might affect their communicative skills (e.g., inhibitory control and cognitive flexibility).

Methods: Ten individuals with chronic TBI took part in and completed the CPT program. The participants' narrative abilities were assessed before and after the CPT program, using a picture description task. Moreover, equivalent forms of the Assessment Battery for Communication (ABaCo), and a series of neuropsychological tasks, were administered to the participants to evaluate their pragmatic skills and cognitive profile.

Results: The CPT program induced a significant improvement in pragmatic and informative skills, while no significant improvement was observed in neuropsychological tasks. Importantly, the improvement in pragmatic abilities persisted three months post-training.

Conclusions: The study highlighted the efficacy of the CPT program in improving patients' informativeness, confirming previous reports of its effectiveness in the rehabilitation of communicative-pragmatic skills.

1. Introduction

Traumatic brain injuries (TBIs) often result in motor, cognitive, and linguistic difficulties that undermine patients' daily-life

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communicative interactions (Bosco, Angeleri, Sacco, & Bara, 2015; Douglas, Bracy, & Snow, 2016; Yeates et al., 2002, for a recent review see; Steel & Togher, 2018). Some of these individuals have microlinguistic (e.g., phonological, lexical and grammatical) impairments. Others may have normal lexical and grammatical skills but may still be unable to communicate because of macro-linguistic impairments that include difficulties in the domains of pragmatics and discourse. These two abilities are strictly related to each other. Namely, pragmatic skills concern the ability to use language in context (Levinson, 1983). This includes the ability to process the meaning of non-literal expressions (e.g., indirect speech acts, irony, metaphors, and proverbs) and sustain a conversational exchange by selecting appropriate pieces of information. The latter, in turn, contribute to the generation of samples of coherent discourse (Matthews, Biney, & Abbot-Smith, 2018). In other words, pragmatic skills set the context in which the process of narrative discourse generation takes place. This massive interference between pragmatic and discourse skills occurs at different stages in the discourse production process. For example, in the prelinguistic conceptual phase of message planning (e.g., Levelt, Roelofs, & Meyer, 1999; Gernsbacher, 1990) the speaker generates the structure of the story to be produced, inhibits the introduction of irrelevant and/or tangential information, and monitors this entire process over time. Importantly, at least three executive components, which are usually impaired in patients with TBI, might be involved in this complex process (Miyake, Friedman, Emerson, Witzki, & Howerter, 2000; Mozeiko, Le, Coelho, Krueger, & Grafman, 2011): *shifting* (or attention switching), likely involved in the generation of complete episodes within a narrative discourse and in the selection of informative words; *updating*, required to recall former episodes or episodic contents for an accurate organization of the story; and *inhibition*, critical for monitoring the production of extraneous comments and derailments while telling a story.

As mentioned earlier, both pragmatic abilities (Bosco, Parola, Sacco, Zettin, & Angeleri, 2017; Honan, McDonald, Gowland, Fisher, & Randall, 2015; Kinsella, Packer, & Olver, 1991; McDonald, 2013b; McDonald et al., 2014; McDonald & Flanagan, 2004; Angeleri et al., 2008; Davis and Coelho, 2004) and discourse skills (e.g., Cannizzaro & Coelho, 2002; Coelho, 2002; Marini, Galetto et al., 2011; Marini, Zettin, Bencich, Bosco, & Galetto, 2017; Marini, Zettin, & Galetto, 2014; Youse & Coelho, 2005) are usually compromised in individuals who have sustained moderate to severe TBI to the extent that their discourse is frequently described as tangential, incoherent, disorganized, and confused by their communicative partners, who also report a reduction in the effectiveness and quality of communication and a sense of effort in communicating with them (Kinsella et al., 1991; McDonald, 2013a). For example, in Marini, Andreetta, et al. (2011) and Marini, Galetto, et al. (2011) non-aphasic individuals with TBI produced frequent interruptions and derailments that reduced the levels of cohesion and coherence of their narratives. As a consequence, the quality of such narratives was seriously affected, with reduced levels of informativeness and poor content organization. Notably, the participants showed no microlinguistic deficits. This ruled out the possibility that lexical or grammatical disturbances could be responsible for their narrative difficulties. Similarly, Carlomagno, Giannotti, Vorano, and Marini (2011) found an increased number of errors of cohesion, and local and global coherence in the narratives of a group of non-aphasic participants with TBI, whose microlinguistic skills were spared. Most importantly for the aims of the present study, in that investigation the authors showed that the production of cohesion and coherence errors predicted the reduced level of lexical informativeness of their narratives. Therefore, the narratives produced by individuals with TBI are usually characterized by decreased levels of local and global coherence that lower the degree of informativeness. These deficits may become chronic in the absence of adequate rehabilitative treatment, with long-term consequences on patients' quality of life (Coelho, Liles, & Duffy, 1991; Hoofien, Gilboa, Vakil, & Donovan, 2009; Snow, Jacinta, & Ponsford, 1998; Demakis et al., 2007; Doctor et al., 2005). Because of their important social and communicative function, narratives should be included in the pragmatic assessment of patients with TBI. Indeed, if tasks specifically targeting pragmatic skills are useful in capturing some pragmatic features of such individuals, narrative production tasks might allow clinicians to gather additional information on their ability to be efficient communicators. This also has implications for rehabilitation and is of interest for the current study.

Several rehabilitative approaches have been proposed to compensate the effects of a communicative-pragmatic disorder and promote social recovery in individuals with TBI. Traditionally, treatment protocols have targeted microlinguistic deficits that are typically found in individuals with aphasic symptoms (see Hillis, Worrall, & Thompson, 2007). These approaches aimed to recover discourse-level skills, such as story grammar, topic maintenance or cohesion, by treating the underlying mechanisms responsible for these anomalies. However, communicative difficulties after TBI are rarely the result of a microlinguistic impairment alone; rather, they are often triggered by deficits in the use of language in a social context. In line with these considerations, over the past 15 years rehabilitation protocols have been enriched with pragmatic approaches that focus on the rehabilitation of communicative skills in real-life settings with a particular attention to contextual aspects (Douglas, 2010; Gabbatore, Sacco, et al., 2014; Hopper, Holland, & Rewega, 2002; Marangolo, Fiori, Caltagirone, & Marini, 2013; McDonald et al., 2008; Togher, McDonald, Tate, Power, & Rietdijk, 2013; Ylvisaker, 2003). McDonald et al. (2008) proposed a social skills training program organized in 12 weekly sessions each lasting 3 h. This rehabilitation program aimed to improve the patients' social behavior by using role-playing. During each session, the therapists were instructed to model the patients' communicative behavior, focusing on their communicative difficulties and devising possible strategies to overcome them. Interestingly, some of these sessions were focused on developing social perception skills by instructing on how to decode the emotional cues carried by the interlocutor's voice, facial expressions, and gestures. Togher, McDonald, Tate, Rietdijk, and Power (2016) proposed a treatment program focused on improving everyday conversational skills, involving the patients' communicative partners. The program was organized in two-and-a-half-hour group sessions over a period of 10 weeks; group activities included role-playing, learning conversational strategies, and feedback reinforcement. This study supported the efficacy of such treatments in improving the communicative interactions of people with TBI with their interlocutors. Most notably, such improvements were still noticeable six months after the end of the training program.

In line with these findings, Finch, Copley, Cornwell, and Kelly (2016) have shown that pragmatic approaches to rehabilitation of social-communication skills (especially those adopting a context-sensitive approach [Ylvisaker, 2003] and lasting for a period of at

least 10 weeks) are more effective than traditional rehabilitative programs. Indeed, the former allow the improvements gained from treatment to be maintained for longer periods and provide stronger evidence of a generalization of treatment to everyday communicative interactions. However, there is still a lack of empirical evidence to guide treatment of narrative discourse deficits after TBI, and only a few of the treatment programs proposed so far have strong theoretical grounds (Cannizzaro & Coelho, 2002; Coelho, 2007; Gindri et al., 2014). Among these, the Cognitive Pragmatic treatment (CPT) program (Bosco, Gabbatore, Gastaldo, & Sacco, 2016; Gabbatore et al., 2015; Gabbatore, Bosco et al., 2017) focuses on improving communicative-pragmatic skills by training different abilities (e.g., conversational skills, social appropriateness, self-awareness, inferential abilities) using a number of expressive means (e.g., language, gestures, facial expressions, prosodic cues). This allows the interlocutors to generate inferences to fill the gap between the literal meaning and the speaker's meaning of a specific utterance. In line with the afore-mentioned relations between pragmatic and discourse skills, there is growing evidence to suggest that such inferences also allow speakers to deal with samples of narrative discourse, as they are required to integrate different pieces of information in the text and establish coherence between the different elements of a story (Beeman, Bowden, & Gernsbacher, 2000; Leonard, Baum, & Pell, 2001). A recent investigation has shown that the complex interplay between discourse and cognitive skills such as memory, attention, and executive functions allows patients with TBI to produce samples of narrative discourse with adequate levels of lexical informativeness (Marini et al., 2017). The CPT program also includes sessions specifically aimed at improving those cognitive functions that underlie communicative skills (e.g., Miyake et al., 2000; Mozeiko et al., 2011). As for narrative discourse and conversational skills, the CPT program includes sessions devoted to training patients in structuring a discourse, in providing their interlocutors with an adequate amount of information, and in selecting the most relevant contents with respect to the topic of the discourse and the listener's needs. For these reasons, CPT may positively enhance narrative production efficiency in individuals with TBI. In that respect, the CPT program has proved its efficacy in individuals with chronic TBI (Gabbatore et al., 2015) by increasing their functional communication skills and promoting brain plasticity (Gabbatore, Bosco et al., 2017). However, no previous studies have assessed the efficacy of CPT in improving the ability to produce relevant pieces of information within a narrative production task using a comprehensive procedure for discourse analysis.

The aim of the present study is to determine the efficacy of the CPT program in improving the ability to produce informative narratives in a cohort of chronic patients suffering from moderate to severe closed-head traumatic brain injury. Importantly, their informative skills were assessed by administering not only a standardized pragmatic protocol (the ABaCo battery developed by Angeleri, Bara, Bosco, Colle, & Sacco, 2015; Bosco, Angeleri, Zuffranieri, Bara, & Sacco, 2012) but also a narrative production task (Marini, Andreetta, et al., 2011) that has proved useful in capturing the narrative and informative skills of patients with brain injuries (e.g., Marini, 2012; Marini, Galetto, et al., 2011) and of healthy individuals (e.g., Marini, Boewe, et al., 2005). We hypothesized that the CPT program would significantly improve the informative skills of the cohort of participants with TBI and that this would determine an increase in both a measure of pragmatic processing derived from the ABaCo battery and a measure of informativeness derived from the analysis of the samples of discourse production. Finally, in line with recent studies supporting the afore-mentioned relation between cognitive abilities and communicative performance (Bosco et al., 2017; Bosco, Gabbatore, Angeleri, Zettin, & Parola, 2018; Bosco & Parola, 2017; Honan et al., 2015; Parola, Berardinelli, & Bosco, 2018; Rowley, Rogish, Alexander, & Riggs, 2017), a battery of cognitive tasks was also administered to the participants (both pre- and post-treatment) in order to explore the potential effect of the CPT program on those cognitive skills that are implicated in the prelinguistic conceptual phase of message planning. Notably, the assessment included not only tasks assessing the patients' executive skills, but also tasks assessing additional skills such as Theory of Mind (ToM) in order to provide a comprehensive account of their cognitive profiles and an additional measure concerning the specificity of the training program. Indeed, we aimed to investigate whether taking part in the Cognitive Pragmatic Training program and potential improvements in pragmatic skills would also have an indirect effect on the cognitive abilities investigated pre- and post-training.

2. Methods

2.1. Participants

Fourteen right-handed male individuals with chronic TBI were selected for this study. Four patients were not able to complete the

Table 1
Demographic and clinical data of individuals with traumatic brain injury.

	Individuals with Traumatic Brain Injury		
	Mean	SD	Range
Demographical data			
Age (years)	41.40	12.18	22–58
Education (years)	10.00	2.94	5–13
Gender (M/F)	10/0		
Clinical Measures			
Glasgow Coma Scale ^a	4.67	1.86	3–8
Time after injury (months)	129.10	97.12	24–312

^a The reported score was determined at the first medical contact in the hospital.

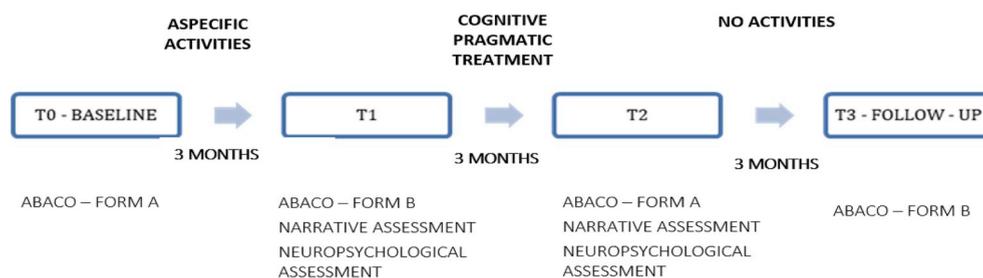


Fig. 1. Schematic structure of the research design.

rehabilitative program due to personal and health problems. Thus, ten individuals with TBI participated and completed the rehabilitative program. Table 1 shows their general characteristics. All of them had suffered from moderate to severe closed-head TBI as a result of road traffic accidents. By the time of their enrollment in the study, all participants were living at home with their caregivers and none of them had a job.

Participants with TBI were recruited at rehabilitation centers in Turin and released their informed consent to participate in the study after all procedures had been fully explained to them. The present research project was approved by the local ethics committee of the Centro Puzzle (Protocol C.E. n. 3, cod. ABACO). Inclusionary criteria were: 1) an age of at least 18 years; 2) being Italian native speakers; 3) being at least 24 months post injury; 4) normal performance on the Mini-Mental State Examination (MMSE, Folstein, Folstein, & McHugh, 1975), cut-off: 24/30; on the Naming scale of the Aachen Aphasia Test (AAT, Huber, Poeck, & Willmes, 1983), cut-off: no deficit; and on the Token Test (De Renzi & Vignolo, 1962), cut-off: > 29/36; 5) absence of aphasic symptoms. Furthermore, individuals with TBI were not included in the study if they had a prior history of TBI or any other neurological or psychiatric diseases as well as pre-morbid alcohol or drug addiction.

2.2. Procedures

The patients' communicative and cognitive skills were assessed in four successive moments (see Fig. 1). In order to set a baseline condition, three months before the treatment program started (T0) the patients' communicative skills were assessed by administering form A of the Assessment Battery for Communication (ABaCo; Angeleri, Bosco, Gabbatore, Bara, & Sacco, 2012; Bosco et al., 2012). In order to rule out the possibility of an improvement in communicative performance uniquely due to spontaneous recovery or to other social or rehabilitative activities undertaken by the patients during this period (as they attended weekly rehabilitative sessions focused on (a) memory and attention group and individual activities (b) socializing activities), one week before the beginning of the treatment program (T1) their communicative and neuropsychological skills were re-assessed using a narrative-discourse production task and form B of the ABaCo. After T1, individuals with TBI were enrolled in the CPT protocol which was delivered twice a week in group sessions over a period of three months (for a detailed description of the treatment see the *Training Program* section). One week after the end of the treatment program (T2), the patients' communicative performance was re-assessed by administering the narrative-discourse production task and form A of the ABaCo. This allowed us to control for the presence of any improvement in communicative performance induced by the CPT program. Finally, three months after the end of the treatment program (T3) the patients' communicative performance was re-assessed by administering form B of the ABaCo in order to determine whether the observed improvement was stable in time.

2.3. Neuropsychological assessment

The neuropsychological assessment included tasks assessing those cognitive functions that may affect patients' narrative performance and communicative skills. Their basic linguistic abilities were assessed by administering the Naming task of the Aachen Aphasia test (Huber et al., 1983). Attentional skills were assessed by administering the Attentional Matrices (Spinnler, 1987). Working memory was assessed by administering the Disyllabic Word Repetition test and Corsi's Block-Tapping test (Spinnler, 1987). Verbal long-term memory was assessed with the Deferred Recall test (Spinnler, 1987). Planning abilities were measured with the Tower of London test (Shallice, 1982). Cognitive flexibility was assessed with the Modified Card Sorting test (Nelson, 1976) and the Trail Making task (Reitan, 1958) (Parts A and B). Non-verbal reasoning was assessed by administering the Raven's Colored Progressive Matrices (Raven & Raven, 2003). Theory of Mind was investigated by using the Sally & Ann task (Wimmer & Perner, 1983) and a selection of Strange Stories task (Happé, 1994).

2.4. Assessment of narrative abilities

The narrative assessment at T1 and T2 was performed on the storytelling elicited by a series of two picture narrative description tasks. Each participant was asked to describe the stories depicted in two single pictures (the scene of a "Picnic" taken from the Western Aphasia Battery (Kertesz, 1982) and the Cookie Theft by Goodglass and Kaplan (1972)). The order of presentation was counterbalanced across subjects. Each storytelling was tape-recorded and transcribed verbatim by two authors. The transcripts

underwent a multilevel procedure for the analysis of narrative language (Marini, Andreetta, et al., 2011) that has been used with several cohorts of patients with TBI (e.g., Ferretti et al., 2017; Galetto, Andreetta, Zettin, & Marini, 2013; Marini, Andreetta, et al., 2011; Marini et al., 2017), and with individuals with no brain injury (e.g., Marini, Boewe et al., 2005). For the purposes of this study, we focused on two measures that can be derived by such analysis: a measure of productivity, i.e., the number of **words** produced by participants during each storytelling; a measure of functional communicativeness, i.e., the **% of Lexical Information Units (%LIUs)** in each storytelling. This percentage is based on the total amount of Lexical Information Units (LIUs) produced by the participants in their narratives. These included those content and function words that were not only phonologically well-formed but also appropriate from a grammatical and pragmatic point of view (Marini & Urgesi, 2012). Those words that had been scored as errors of any kind as well as words embedded in filler, repeated, incongruent or tangential utterances were excluded from the count of the lexical information units. The percentage of Lexical Informativeness was calculated using the following formula: $((\text{lexical information units}/\text{words}) * 100)$. For an example of this analysis, please refer to [Appendix A](#). The scoring procedure was performed independently by two raters and then compared. Acceptable inter-rater reliability was set at Cohen's $k \geq 0.80$. Any residual difference was resolved through discussion.

2.5. Assessment of communicative pragmatic abilities

The assessment of patients' communicative skills was performed by administering the equivalent forms of the ABAco battery (Angeleri et al., 2015; Bosco et al., 2012) at different time periods (i.e., T0, T1, T2 and T3). Such equivalent forms are constituted by 68 items each, of the same difficulty level but different content (see Bosco et al., 2012). The equivalent forms allow to measure treatment efficacy through test-retest procedures, but excluding the possible confounding effect of learning and memory. The equivalent forms of the ABAco comprise four scales (i.e. *linguistic*, *extralinguistic*, *paralinguistic*, and *context scales*) that investigate different aspects of communication. The linguistic and extralinguistic scales assess the ability to understand and produce different communicative acts expressed through the use of language or through a non-verbal modality (e.g., extralinguistic features such as gestures or facial expressions). The paralinguistic scale assesses the ability to recognize and produce paralinguistic features such as prosody or vocal markers that accompany a communicative act. The context scale assesses the adequacy of a communication to the norms of social appropriateness and to the conversational rules outlined by Grice. Each scale, in turn, includes a comprehension and production subscale, that assesses comprehension and production abilities in each communication modality. Each scale comprises a series of tasks that require participants to understand or produce a communicative act in response to the prompt of the examiner, or to a video-recorded scene in which two actors represent a communicative exchange. As a result of these scales, the ABAco battery provides a global index of communicative-pragmatic performance. Data were coded off-line by two independent raters based on the videorecording of the administration sessions and according to the scoring procedure reported in the ABAco's instruction manual. The scores for each task ranged from 0 (incorrect answer) to 1 (correct answer) for each item. More details concerning the structure of the Assessment Battery for Communication and its scoring procedures are provided in Angeleri et al. (2012), Parola et al. (2016, 2018). We used the Intraclass Correlation Coefficient (ICC) to calculate the agreement between the two raters. The ICC calculated for a subsample of our scores was 0.88, that according to Altman (1991) indicates a high value of inter-rater agreement.

2.6. Training program

The CPT was implemented over a period of three months in group sessions that took place twice a week. Each group comprised 5 individuals with TBI. Each session, lasting approximately 1.5 h with a 10 min' break in the middle was coordinated by two trained psychologists and video-taped. The CPT is designed to enhance different aspects of a communicative interaction (e.g., conversational skills, narrative competence, and social appropriateness) by means of linguistic, extralinguistic, and paralinguistic abilities. The treatment focuses primarily on the pragmatic level of communication. A part of the treatment is specifically focused on the enhancement of narrative skills, using speech elicitation and story-telling tasks. The primary aim of the treatment is therefore to increase the participants' ability to deal with the inferential processes that underlie their communicative behavior, rather than just suggesting patients to apply adaptive communicative strategies in everyday-life situations. An additional part of the training focuses on the improvement of those cognitive and social abilities that underpin communication, such as executive functions and theory of mind. Each week was devoted to develop a specific aspect of communication (for a schematic structure of the sessions that made up the CPT, please see [Appendix B](#)). Each session followed a similar structure (see [Appendix C](#) for an example of a rehabilitative session): a warm-up phase in which the therapists invited the participants to recall and discuss about what they had done in the previous session. Then the participants were shown video or audio materials in which actors were simulating a communicative exchange. Once the simulations had been over, they were invited to 1) share their thoughts about what they had just seen, 2) identify potential communicative failures, and 3) find the most adequate communicative behavior for those specific situations. In the second part of each session the participants were invited to take part to practical activities such as role-playing, in which they were requested to interactively perform a communicative exchange following the instructions and respecting the constraints provided by the therapists. In doing so, the therapists invited the participants to focus on the inferential processes involved during the communicative exchange and help them find the most functional communicative strategy. For a comprehensive description of the structure, the content of the single sessions and the theoretical background of the CPT please refer to Gabbatore et al. (2015), Sacco et al. (2016), Bosco et al. (2016), Gabbatore, Bosco et al. (2017).

Table 2

Performance on the narrative production task (mean and standard deviation) before and after the CPT.

Narrative assessment	T1 – Pre training	T2 – Post training	Level of significance	Effect Size (Cohen's d)
Words produced	99.50 (59.90)	100 (54.10)	1.00	.04
% of Lexical Information Units	68.72 (11.00)	74.50 (10.10)	< .05	.92

2.7. Statistical methods

In order to identify potential differences in neuropsychological scores in individuals with TBI before and after the treatment, a series of two paired-samples T-tests were performed. The presence of significant differences before and after the treatment in the two narrative measures considered for this study (i.e., words produced and % LIUS, see Table 2), was determined by using two paired-samples T-tests with the number of words and the %LIUs at T1 and T2 as dependent variables.

Finally, in order to assess potential differences in the communicative performance of individuals with TBI before and after treatment we used a 2×2 repeated-measures analysis of variance (ANOVA) with overall ABaCo performance as the dependent variable, and Treatment (two levels: Pre-treatment assessments [T0 and T1] and Post-treatment assessments [T2 and T3]) and Control Condition (two levels: Baseline [T0 and T2] and Follow-up [T1 and T3]) as within-subjects fixed factors. The aim of the analysis was to evaluate the differences in the communicative performance due to the specific effect of the CPT, i.e. differences between pre-treatment [T0 and T1] and post-treatment assessments [T2 and T3], and at the same time to control that improvements in communicative performance were not due to spontaneous recovery (differences between T0 and T1) and were stable after the end of the treatments (differences between T2 and T3).

All p-values were adjusted using the Bonferroni correction to account for multiple comparisons.

3. Results

3.1. Neuropsychological assessment

The results showed no significant differences ($.58 < t_{(1,9)} < 2.24$; $.53 < p < 1.0$). See Table 3.

3.2. Narrative assessment

The analyses showed that the production of words remained stable across the two time-periods [$t_{(8)} = 0.256$; $p = 1.00$], whereas at T2 the patients produced a significantly higher percentage of Lexical Information Units [$t_{(8)} = 2.721$; $p < .05$]. This is an interesting result as it suggests that the quality of their informational skills improved significantly after the training with the CPT.

3.3. Communicative-pragmatic assessment

The results showed a main effect of Treatment ($F_{(1,9)} = 45.63$, $p < .001$, $\eta_p^2 = .83$), indicating that communicative performance of individuals with TBI on the ABaCo was significantly better after (T2 and T3) than before the treatment (T0 and T1). The main effect of Control condition ($F_{(1,9)} = .346$, $p = .571$, $\eta_p^2 = .04$), and the interaction between Treatment X Control Condition ($F_{(1,9)} = .117$, $p = .740$, $\eta_p^2 = .01$) was not significant. This result indicates that there were no significant differences in the communicative performance between the two assessments before the treatments (T0 and T1) due to spontaneous recovery of patients, and there were no significant differences between the two assessments before the treatments (T2 and T3), thus suggesting that the improvement observed after the treatment was stable in time. See Table 4.

Table 3

Cognitive profile (means and standard deviations) of patients with TBI before and after the CPT.

Neuropsychological test	T1 – Pre training	T2 – Post training	Level of significance	Effect Size (Cohen's d)
Aachener Aphasia test	113.7 (4.8)	114.5 (5.0)	1.00	.17
Attentional Matrices	39.2 (8.6)	36.2 (10.6)	1.00	.32
Trail Making test (B-A) ²	87.57 (68.2)	68.67 (13.5)	1.00	.36
Verbal span	3.58 (0.6)	4.1 (0.9)	.57	.71
Corsi's Block-Tapping test	4.65 (1.0)	4.4 (0.9)	1.00	.24
Immediate and deferred recall test	9.94 (2.4)	11.38 (2.2)	1.00	.59
Tower of London test	22.2 (5.0)	24.1 (5.1)	1.00	.50
Modified Card Sorting test	35.5 (10.32)	39.4 (7.9)	.53	.72
Raven Colored Progressive Matrices	28.6 (4.6)	29 (4.3)	1.00	.23
Sally & Ann	90.0 (32.0)	90.0 (32.0)	1.00	.00
Strange Stories	4.3 (1.5)	4.6 (1.4)	1.00	.24

Table 4

Means and standard deviations of ABaCo global scores of individual with TBI in the different times of the experimental design (T0, T1, T2, T3).

TIME	ABaCo – global score	
	Mean	SD
T0 - Baseline	76.3	12.0
T1 – Pre-treatment	78.5	11.1
T2 – Post-treatment	85.3	7.8
T3 – Follow-up	86.4	7.2

4. Discussion

The present study investigated the efficacy of the CPT program in improving pragmatic and informative skills in a cohort of chronic patients with moderate to severe traumatic brain injury. Previous studies have shown the CPT program to be effective in promoting communication skills and brain plasticity in individuals with chronic TBI (Bosco, Parola, Angeleri, Galetto, Zettin, & Gabbatore, 2018; Gabbatore et al., 2015; Sacco et al., 2016). Importantly, no previous studies have explored the efficacy of the CPT program in improving informative skills while producing samples of narrative discourse. The participants were tested three months before the treatment program started (T0) by administering form A of the ABaCo. This provided their baseline communicative performance and allowed us to rule out the possibility that spontaneous recovery or any other social or rehabilitative activity undertaken by the patients during that period could have biased any potential improvement in their communicative performance. A week before the beginning of the treatment program (T1) the patients' communicative performance was re-assessed using the narrative-discourse production task and the equivalent form B of the ABaCo. On this occasion, patients were also administered tasks to assess their cognitive profile. After T1, individuals with TBI attended CPT group sessions twice a week over a period of three months; one week after the end of the treatment program (T2), they underwent the same evaluation procedure they had received before the program began (at T0), in order to assess the presence of any significant cognitive and/or communicative improvements. Finally, their communicative skills were reassessed with form B of the ABaCo three months after the end of the treatment program (T3-follow up).

The results revealed a significant improvement in the level of informativeness of the narratives produced after the rehabilitative program. Specifically, after the treatment program the patients produced a significantly higher percentage of Lexical Information Units, i.e. words that were not only phonologically well formed but also appropriate from a grammatical and pragmatic point of view (Marini, Carlomagno, Caltagirone, & Nocentini, 2005). The percentage of Lexical Information Units within a speech sample, a measure traditionally not included in linguistic assessment tasks, has proved to be a reliable index to quantify the degree of informativeness of speech production in several clinical conditions, such as in individuals with brain damage (Marini et al., 2005, 2017) and psychiatric disorders (Marini et al., 2008). This suggests that CPT significantly improved the patients' ability to identify and produce the relevant information units during a narrative discourse production task. On the contrary, the total number of words produced by the participants remained stable after the treatment program. This suggests that their informative skills had improved, since the words they produced were more adequate in relation to the given context. Notably, this was precisely the target of specific CPT sessions aimed at providing patients with strategies to select the most informative and relevant contents with respect to the conversational topic.

This result has relevant clinical implications. Indeed, the improvement in informative skills observed in the present study may be extended to patients' daily communicative exchanges. This is particularly important, as previous studies have shown that deficits in discourse production may become chronic if left untreated. This is even more relevant if one considers that impairments in narrative and discourse skills have been identified as one of the major obstacles to returning to work and as a predictor of quality of life in these individuals (Coelho et al., 1991; Hoofien et al., 2009; Snow et al., 1998; Meulenbroek & Turkstra, 2016). Furthermore, it should be stressed that such improvement was observed in patients in a chronic post-injury phase, i.e., at least two years after the TBI.

The efficacy of CPT in improving pragmatic aspects of communication was confirmed by the analysis of the performance of TBI patients on the ABaCo. A significant increase was observed in patients' global performance scores on the ABaCo obtained post-treatment compared to pre-treatment. Improvements in communicative-pragmatic skills persisted three months after the end of the treatment program (T3), as confirmed by the results of the follow-up assessment. Notably, no significant differences were found in communicative abilities as measured with the ABaCo between the baseline assessments (T0, three months before the treatment program started) and the pre-treatment assessment (T1), excluding the possibility that the improvement in communicative performance observed after the treatment might have been due to a process of spontaneous recovery or any other social or rehabilitative activity in which patients were involved during that period. This consolidates previous studies that have demonstrated the efficacy of CPT in improving the communicative skills of individuals with TBI (Bosco et al., 2018; Gabbatore et al., 2015; Sacco et al., 2016). In line with previous reviews and reports (e.g., Dahlberg et al., 2006; Finch et al., 2016; McDonald et al., 2008; Togher et al., 2016), the current investigation supports the hypotheses that 1) patients in the chronic post-injury phase and with long-term cognitive and communicative impairments may still benefit from social communication training procedures, 2) improvements in social communication skills may persist even three months after treatment in studies adopting a context-sensitive approach and lasting for a period of at least 10 weeks. The use of a context-sensitive approach, specifically aimed at improving functional communication and focused

on the patient's specific impairment, would appear to be particularly suitable for rehabilitation of communicative deficits in patients with chronic TBI.

The neuropsychological assessment before and after treatment failed to show any significant improvement in cognitive tasks after CPT. On the contrary, significant treatment-related improvements were observed in performance on all communicative tasks, i.e. the ABaCo and the informative levels of the samples of narrative discourse. This supports the specificity of CPT in improving communicative-pragmatic abilities, rather than general cognitive skills such as executive functions. However, we only included a limited set of cognitive tasks to assess cognitive functions that may be relevant to communicative-pragmatic performance (such as working memory, inhibition, planning); in addition, even if the differences between cognitive and ToM measures pre- and post-treatment were not significant, these differences had medium to large effect sizes. Thus, also considering the limited sample size of the present study, future research is needed in order to better evaluate the role of cognitive functions in sustaining patients' improvements in communicative-pragmatic performance after CPT.

Overall, these results support those of previous investigations showing that pragmatic deficits are not necessarily associated with other patients' cognitive difficulties, such as executive functions and social cognition (Bambini et al., 2016; Bosco, Tirassa, & Gabbatore, 2018; Carotenuto et al., 2018; Cummings, 2017; Parola et al., 2018) and suggest the need to adopt rehabilitative programs that include the enhancement of a patient's pragmatic skills.

5. Limitations

The current study has some limitations. One is the small sample size. Unfortunately, only ten patients out of the fourteen participants initially enrolled in the program completed the treatment. Future studies are required to provide additional evidence with larger samples. In our opinion, future studies should also adopt controlled cross-over designs. However, even considering the limited sample size, we found a significant effect in both the measures used to quantify communicative improvements in patients with TBI after the treatment program; in addition, we ruled out the possibility that communicative improvements might be a mere side-effect of a process of spontaneous recovery. This evidence apparently confirms that the improvement was a true effect, specifically due to the targeted rehabilitative treatment undergone by the patients. Another limitation is represented by the lack of an external measure to assess the generalizability of the improvements exhibited by patients after the treatment concerning their quality of life. Few previous studies (e.g., Cruice, Worrall, Hickson, & Murison, 2003; Dahlberg et al., 2006) have assessed the association between communicative performance in discourse tasks and health-related quality of life. It would be useful in future studies to explore the impact of CPT in improving such aspects. A third limitation concerns the fact that the study was not fully controlled. Indeed, no information was available at T0 for the narrative assessment. This was due to the fact that, unfortunately, we did not have any equivalent form of the narrative task, which we did, instead, have for the ABaCo. This leaves open the possibility that the observed improvement in the levels of lexical informativeness might have been related to some degree of spontaneous recovery. However, this possibility is unlikely, as none of the patients showed any spontaneous recovery on the ABaCo or in the cognitive assessment. Again, future studies should consider this limitation and override it by using narrative discourse tasks with equivalent forms that would avoid any learning effect.

6. Conclusions

The present study provides quantitative evidence supporting the efficacy of CPT in improving the ability of patients with chronic TBI to produce informative samples of narrative discourse. The results also highlight that improvements in communicative performance were maintained three months after the end of the CPT program. This study confirms previous findings showing the effectiveness of CPT in improving functional communication and brain plasticity in individuals with chronic TBI, and provides additional evidence supporting the specificity of CPT in remediating communicative-pragmatic ability and narrative production.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jneuroling.2018.12.003>.

References

- Angeleri, R., Bara, B. G., Bosco, F. M., Colle, L., & Sacco, K. (2015). *Batteria per L'assessment della comunicazione (ABaCo)*. Firenze: Giunti OS Organizzazioni Speciali.
- Angeleri, R., Bosco, F. M., Gabbatore, I., Bara, B. G., & Sacco, K. (2012). Assessment battery for communication (ABaCo): Normative data. *Behavior Research Methods*, 44(3), 845–861.
- Angeleri, R., Bosco, F. M., Zettin, M., Sacco, K., Colle, L., & Bara, B. G. (2008). Communicative impairment in traumatic brain injury: A complete pragmatic assessment. *Brain and Language*, 107(3), 229–245.
- Bambini, V., Arcara, G., Bechi, M., Buonocore, M., Cavallaro, R., & Bosia, M. (2016). The communicative impairment as a core feature of schizophrenia: Frequency of

- pragmatic deficit, cognitive substrates, and relation with quality of life. *Comprehensive Psychiatry*, 71, 106–120.
- Beeman, M. J., Bowden, E. M., & Gernsbacher, M. A. (2000). Right and left hemisphere cooperation for drawing predictive and coherence inferences during normal story comprehension. *Brain and Language*, 71(2), 310–336.
- Bosco, F. M., Angelieri, R., Sacco, K., & Bara, B. G. (2015). Explaining pragmatic performance in traumatic brain injury: A process perspective on communicative errors. *International Journal of Language & Communication Disorders*, 50(1), 63–83.
- Bosco, F. M., Angelieri, R., Zuffranieri, M., Bara, B. G., & Sacco, K. (2012). Assessment battery for communication: Development of two equivalent forms. *Journal of Communication Disorders*, 45(4), 290–303.
- Bosco, F. M., Gabbatore, I., Angelieri, R., Zettin, M., & Parola, A. (September–October 2018). Do executive function and theory of mind predict pragmatic abilities following traumatic brain injury? An analysis of sincere, deceitful and ironic communicative acts. *Journal of Communication Disorders*, 75, 102–117.
- Bosco, F. M., Gabbatore, I., Gastaldo, L., & Sacco, K. (2016). Communicative-pragmatic treatment in schizophrenia: A pilot study. *Frontiers in Psychology*, 7, 1–12.
- Bosco, F. M., & Parola, A. (2017). Schizophrenia. In L. Cummings (Vol. Ed.), *Research in clinical pragmatics. Perspectives in pragmatics, philosophy & psychology*: 11. Cham: Springer.
- Bosco, F. M., Parola, A., Angelieri, R., Galetto, V., Zettin, M., & Gabbatore, I. (2018). *Improvement of communication skills after traumatic brain injury: The efficacy of the cognitive pragmatic treatment program using the communicative activities of daily living*. Archives of Clinical Neuropsychology 041.
- Bosco, F. M., Parola, A., Sacco, K., Zettin, M., & Angelieri, R. (2017). Communicative-pragmatic disorders in traumatic brain injury: The role of theory of mind and executive functions. *Brain and Language*, 168, 73–83.
- Bosco, F. M., Tirassa, M., & Gabbatore, I. (2018). Why pragmatics and Theory of Mind do not (Completely) overlap. *Frontiers in Psychology*, 9, 1453.
- Cannizzaro, M. S., & Coelho, C. A. (2002). Treatment of story grammar following traumatic brain injury: A pilot study. *Brain Injury*, 16(12), 1065–1073.
- Carlomagno, S., Giannotti, S., Vorano, L., & Marini, A. (2011). Discourse information content in non-aphasic adults with brain injury: A pilot study. *Brain Injury*, 25(10), 1010–1018.
- Carotenuto, A., Arcara, G., Orefice, G., Cerillo, I., Giannino, M. R., Iodice, R., et al. (2018). Pragmatic abilities in multiple sclerosis: The contribution of the temporo-parietal junction. *Brain and Language*, 185, 47–53.
- Coelho, C. A. (2002). Story narratives of adults with closed head injury and non-brain-injured adults: Influence of socioeconomic status, elicitation task, and executive functioning. *Journal of Speech Language Hearing Research: Journal of Speech Language Hearing Research*, 45(6), 1232–1248.
- Coelho, C. A. (2007). Management of discourse deficits following traumatic brain injury: Progress, caveats, and needs. *Seminars in Speech and Language*, 28(2), 122–135.
- Coelho, C. A., Liles, B. Z., & Duffy, R. J. (1991). Discourse analyses with closed head injured adults: Evidence for differing patterns of deficits. *Archives of Physical Medicine & Rehabilitation*, 72(7), 465–468.
- Cruise, M., Worrall, L., Hickson, L., & Murison, R. (2003). Finding a focus for quality of life with aphasia: Social and emotional health, and psychological well-being. *Aphasiology*, 17(4), 333.
- Cummings, L. (2017). Cognitive aspects of pragmatic disorders. In Cummings (Ed.), *Research in clinical pragmatics*. Dordrecht: Springer International Publishing. L.
- Dahlberg, C., Hawley, L., Morey, C., Newman, J., Cusick, C. P., & Harrison-Felix, C. (2006). Social communication skills in persons with post-acute traumatic brain injury: Three perspectives. *Brain Injury*, 20(4), 425–435.
- Davis, G. A., & Coelho, C. A. (2004). Referential cohesion and logical coherence of narration after closed head injury. *Brain and Language*, 89(3), 508–523.
- De Renzi, E., & Vignolo, L. A. (1962). The token test: A sensitive test to detect receptive disturbances in aphasics. *Brain*, 85(4), 665–678.
- Demakis, G. J., Hammond, F., Knotts, A., Cooper, D. B., Clement, P., Kennedy, J., et al. (2007). The personality assessment inventory in individuals with traumatic brain injury. *Archives of Clinical Neuropsychology*, 22(1), 123–130.
- Doctor, J. N., Castro, J., Temkin, N. R., Fraser, R. T., Machamer, J. E., & Dikmen, S. S. (2005). Workers' risk of unemployment after traumatic brain injury: A normed comparison. *Journal of the International Neuropsychological Society*, 11(6), 747–752.
- Douglas, J. M. (2010). Relation of executive functioning to pragmatic outcome following severe traumatic brain injury. *Journal of Speech Language Hearing Research*, 53(April), 365–383.
- Douglas, J. M., Bracy, C. A., & Snow, P. C. (2016). Return to work and social communication ability following severe traumatic brain injury. *Journal of Speech Language Hearing Research*, 59(3), 511.
- Ferretti, F., Adornetti, I., Chiera, A., Nicchiarelli, S., Magni, R., Valeri, G., et al. (2017). Mental time travel and language evolution: A narrative account of the origins of human communication. *Language Sciences*, 63, 105–118.
- Finch, E., Copley, A., Cornwell, P., & Kelly, C. (2016). Systematic review of behavioral interventions targeting social communication difficulties after traumatic brain injury. *Archives of Physical Medicine and Rehabilitation*, 97(8), 1352–1365.
- Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). "Mini-mental state": A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*, 12(3), 189–198.
- Gabbatore, I., Angelieri, R., Bosco, F. M., Cossa, F. M., Bara, B. G., & Sacco, K. (2014). Assessment of communicative abilities in aphasic patients. *Minerva Psichiatrica*, 55, 45–55.
- Gabbatore, I., Bosco, F. M., Geda, E., Gastaldo, L., Duca, S., Costa, T., et al. (2017). Cognitive pragmatic rehabilitation program in schizophrenia: A single case fMRI study. *Neural Plasticity* 1612078.
- Gabbatore, I., Sacco, K., Angelieri, R., Zettin, M., Bara, B. G., & Bosco, F. M. (2015). Cognitive pragmatic treatment: A rehabilitative program for traumatic brain injury individuals. *The Journal of Head Trauma Rehabilitation*, 30(5), E14–E28.
- Galetto, V., Andreotta, S., Zettin, M., & Marini, A. (2013). Patterns of impairment of narrative language in mild traumatic brain injury. *Journal of Neurolinguistics*, 26(6), 649–661.
- Gernsbacher, M. A. (1990). *Language comprehension as structure building*. Hillsdale, NJ: Erlbaum.
- Gindri, G., Pagliarin, K. C., Casarin, F. S., Ferré, P., Joannette, Y., & Fonseca, R. P. (2014). Rehabilitation of discourse impairments after acquired brain injury. *Dementia & Neuropsychologia*, 8(1), 58–65.
- Goodglass, H., & Kaplan, E. (1972). *The boston diagnostic aphasia examination*. Philadelphia, PA: Lea & Febiger.
- Happé, F. G. E. (1994). An advanced test of theory of mind: Understanding of story characters' thoughts and feelings by able autistic, mentally handicapped, and normal children and adults. *Journal of Autism and Developmental Disorders*, 24(2), 129–154.
- Hillis, A., Worrall, L., & Thompson, C. (2007). The state of impairment and consequences-based approaches to treatment for aphasia. In N. Martin, C. Thompson, & L. Worrall (Eds.), *Aphasia Rehabilitation: The impairment and its consequences* (pp. 261–269). San Diego, CA: Plural Publishing, Inc.
- Honan, C. A., McDonald, S., Gowland, A., Fisher, A., & Randall, R. K. (2015). Deficits in comprehension of speech acts after TBI: The role of theory of mind and executive function. *Brain and Language*, 150, 69–79.
- Hooftien, D., Gilboa, A., Vakil, E., & Donovick, P. J. (2009). Traumatic brain injury (TBI) 10–20 years later: A comprehensive outcome study of psychiatric symptomatology, cognitive abilities and psychosocial functioning. *Brain Injury*, 189–209 9052(15(3)).
- Hopper, T., Holland, A., & Rewega, M. (2002). Conversational coaching: Treatment outcomes and future directions. *Aphasiology*, 16(7), 745–761.
- Huber, W., Poeck, K., & Willmes, K. (1983). The aachen aphasia test. *Advances in Neurology*, 42, 291–303.
- Kertesz, A. (1982). *Western aphasia battery*. New York, NY: Grune and Stratton.
- Kinsella, G., Packer, S., & Olver, J. (1991). Maternal reporting of behaviour following very severe blunt head injury. *Journal of Neurology Neurosurgery and Psychiatry*, 54(5), 422–426.
- Leonard, C. L., Baum, S. R., & Pell, M. D. (2001). The effect of compressed speech on the ability of right-hemisphere-damaged patients to use context. *Cortex*, 37(3), 327–344.
- Levelt, W. J. M., Roelofs, A., & Meyer, A. S. (1999). A theory of lexical access in speech production. *Behavioral and Brain Sciences*, 22, 1–38.
- Levinson, S. C. (1983). *Pragmatics*. Cambridge, UK: Cambridge University Press.
- Marangolo, P., Fiori, V., Caltagirone, C., & Marini, A. (2013). How Conversational Therapy influences language recovery in chronic non-fluent aphasia.

- Neuropsychological Rehabilitation*, 23(5), 715–731.
- Marini, A. (2012). Characteristics of narrative discourse processing after damage to the right hemisphere. *Seminars in Speech and Language*, 33(1), 68–78.
- Marini, A., Andreetta, S., del Tin, S., & Carlomagno, S. (2011). A multi-level approach to the analysis of narrative language in aphasia. *Aphasiology*, 25(11), 1372–1392.
- Marini, A., Boewe, A., Caltagirone, C., & Carlomagno, S. (2005). Age-related differences in the production of textual descriptions. *Journal of Psycholinguistic Research*, 34(5), 439–463.
- Marini, A., Carlomagno, S., Caltagirone, C., & Nocentini, U. (2005). The role played by the right hemisphere in the organization of complex textual structures. *Brain and Language*, 93(1), 46–54.
- Marini, A., Galetto, V., Zampieri, E., Vorano, L., Zettin, M., & Carlomagno, S. (2011). Narrative language in traumatic brain injury. *Neuropsychologia*, 49(10), 2904–2910.
- Marini, A., Spoletini, I., Rubino, I. A., Ciuffa, M., Bria, P., Martinotti, G., et al. (2008). The language of schizophrenia: An analysis of micro and macrolinguistic abilities and their neuropsychological correlates. *Schizophrenia Research*, 105(1–3), 144–155.
- Marini, A., & Urgesi, C. (2012). Please get to the point! A cortical correlate of linguistic informativeness. *Journal of Cognitive Neuroscience*, 24(11), 2211–2222.
- Marini, A., Zettin, M., Bencich, E., Bosco, F. M., & Galetto, V. (2017). Severity effects on discourse production after TBI. *Journal of Neurolinguistics*, 44, 91–106.
- Marini, A., Zettin, M., & Galetto, V. (2014). Cognitive correlates of narrative impairment in moderate traumatic brain injury. *Neuropsychologia*, 64, 282–288.
- Matthews, D., Biney, H., & Abbot-Smith, K. (2018). Individual differences in children's pragmatic ability: A review of associations with formal language, social cognition, and executive functions. *Language Learning and Development*, 14(3), 186–223.
- McDonald, S. (2013a). Impairments in social cognition following severe traumatic brain injury. *Journal of the International Neuropsychological Society*, 19(3), 231–246.
- McDonald, S. (2013b). Impairments in social cognition following severe traumatic brain injury. *Journal of the International Neuropsychological Society*, 19(3), 231–246.
- McDonald, S., & Flanagan, S. (2004). Social perception deficits after traumatic brain injury: Interaction between emotion recognition, mentalizing ability, and social communication. *Neuropsychology*, 18(3), 572–579.
- McDonald, S., Gowland, A., Randall, R., Fisher, A., Osborne-Crowley, K., & Honan, C. (2014). Cognitive factors underpinning poor expressive communication skills after traumatic brain injury: Theory of mind or executive function? *Neuropsychology*, 28(5), 801–811.
- McDonald, S., Tate, R., Togher, L., Bornhofen, C., Long, E., Gertler, P., et al. (2008). Social skills treatment for people with severe, chronic acquired brain injuries: A multicenter trial. *Archives of Physical Medicine and Rehabilitation*, 89(9), 1648–1659.
- Meulenbroek, P., & Turkstra, L. S. (2016). Job stability in skilled work and communication ability after moderate-severe traumatic brain injury. *Disability & Rehabilitation*, 38(5), 452–461.
- Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., & Howerter, A. (2000). The unity and diversity of executive functions and their contributions to complex “frontal lobe” tasks: A latent variable analysis. *Cognitive Psychology*, 41, 49–100.
- Mozeiko, J., Le, K., Coelho, C., Krueger, F., & Grafman, J. (2011). The relationship of story grammar and executive function following TBI. *Aphasiology*, 25, 826–835.
- Nelson, H. E. (1976). A modified card sorting test sensitive to frontal lobe defects. *Cortex*, 12(4), 313–324.
- Parola, A., Berardinelli, L., & Bosco, F. M. (2018). Cognitive abilities and theory of mind in explaining communicative-pragmatic disorders in patients with schizophrenia. *Psychiatry Research*, 260, 144–151.
- Parola, A., Gabbatore, I., Bosco, F. M., Bara, B. G., Cossa, F. M., Gindri, P., et al. (2016). Assessment of pragmatic impairment in right hemisphere damage. *Journal of Neurolinguistics*, 39, 10–25.
- Raven, J., & Raven, J. (2003). *Raven progressive Matrices. Handbook of nonverbal assessment*.
- Reitan, R. (1958). Validity of the Trail Making Test as an indicator of organic brain damage. *Perceptual & Motor Skills*, 8, 271–276.
- Rowley, D. A., Rogish, M., Alexander, T., & Riggs, K. J. (2017). Cognitive correlates of pragmatic language comprehension in adult traumatic brain injury: A systematic review and meta-analysis. *Brain Injury*, 31(12), 1564–1574.
- Sacco, K., Gabbatore, I., Geda, E., Duca, S., Cauda, F., Bara, B. G., et al. (2016). Rehabilitation of communicative abilities in patients with a history of TBI: Behavioral improvements and cerebral changes in resting-state activity. *Frontiers in Behavioral Neuroscience*, 10, 48.
- Shallice, T. (1982). Specific impairments of planning. *Philosophical Transactions of the Royal Society of London - Series B: Biological Sciences*, 298(1089), 199–209.
- Snow, P., Jacinta, D., & Ponsford, J. (1998). Conversational discourse abilities following severe traumatic brain injury: A follow up study. *Brain Injury*, 12(11), 911–935.
- Spinnler, H. (1987). Standardizzazione e taratura italiana di test neuropsicologici. *Italian Journal of Neurological Science*, 6, 21–120.
- Steel, J., & Togher, L. (2018). Social communication assessment after TBI: A narrative review of innovations in pragmatic and discourse assessment methods. *Brain Injury*. <https://doi.org/10.1080/02699052.2018.1531304>.
- Togher, L., McDonald, S., Tate, R., Power, E., & Rietdijk, R. (2013). Training communication partners of people with severe traumatic brain injury improves everyday conversations: A multicenter single blind clinical trial. *Journal of Rehabilitation Medicine*, 45(7), 637–645.
- Togher, L., McDonald, S., Tate, R., Rietdijk, R., & Power, E. (2016). The effectiveness of social communication partner training for adults with severe chronic TBI and their families using a measure of perceived communication ability. *NeuroRehabilitation*, 38(3), 243–255.
- Wimmer, H., & Perner, J. (1983). Beliefs about beliefs: Representation and constraining function of wrong beliefs in young children's understanding of deception. *Cognition*, 13(1), 103–128.
- Yeates, K. O., Taylor, H. G., Wade, S. L., Drotar, D., Stancin, T., & Minich, N. (2002). A prospective study of short- and long-term neuropsychological outcomes after traumatic brain injury in children. *Neuropsychology*, 16(4), 514–523.
- Ylvisaker, M. (2003). Context-sensitive cognitive rehabilitation after brain injury: Theory and practice. *Brain Impairment*, 4(1), 1–16.
- Youse, K. M., & Coelho, C. a. (2005). Working memory and discourse production abilities following closed-head injury. *Brain Injury: [BIJ]*, 19(12), 1001–1009.