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Improvement of Communication Skills after Traumatic Brain Injury: The Efficacy of the Cognitive Pragmatic Treatment Program using the Communicative Activities of Daily Living

F.M. Bosco[1,2], A. Parola[1,*], R. Angeleri[3], V. Galetto[4], M. Zettin[4], I. Gabbatore[1,5]

[1]*Department of Psychology, University of Turin, Turin, Italy*
[2]*Institute of Neurosciences of Turin, Italy*
[3]*Department of Psychology, University of New Mexico, USA*
[4]*Centro Puzzle, Turin, Italy*
[5]*Child Language Research Center, Research Unit of Logopedics, University of Oulu, Finland*

*Corresponding author at: Department of Psychology, University of Turin, Via Po 14, 10131 Turin, Italy. Tel.: +390-1167-0365.
E-mail address: alparola@unito.it (A. Parola)

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Abstract

Objective: The pragmatic impairment often characterizing individuals after a traumatic brain injury (TBI) significantly limits their independence, preventing social participation. Rehabilitation programs aim to improve the impaired capacities to help participants communicate effectively, increasing their self-perceived life quality. The aim of this study was to verify the effectiveness of the Cognitive Pragmatic Treatment (CPT) in improving communication abilities after TBI, thus enabling better management of communication activities in daily living.

Method: Nineteen individuals with TBI in a post-acute phase completed the CPT, a group-based training program designed to improve pragmatic abilities. Pre- and post-training, participants were administered the Communication Activities of Daily Living (CADL-2), and the equivalent forms of the Assessment Battery for Communication (ABaCo).

Results: Comparison of pre- and post-training performance showed an overall improvement in pragmatic abilities. Post-training, participants scored higher in communication skills on both the CADL-2 and ABaCo, with such scores remaining constant at a 3-month follow–up assessment.

Conclusions: This study showed that the CPT was effective in improving the participants' communicative abilities. The possibility that the benefits of the CPT may generalize to everyday communicative interactions is discussed.

Keywords: Rehabilitation; Traumatic brain injury; Pragmatics; Functional communication; Language; Theory of mind; Executive functions

Introduction

Traumatic brain injury (TBI) can lead to severe long-term consequences in terms of cognitive impairment that can limit the individual's independence in performing daily activities (Douglas, Bracy, & Snow, 2016; Engberg & Teasdale, 2004; Prigatano, 1987; Sherer, Madison, & Hannay, 2000; Taylor et al., 2002a). Among the problems following TBI are communicative difficulties, which may persist for decades after the TBI occurred (Raymont, Salazar, Krueger, & Grafman, 2011), or after other cognitive deficits have been recovered. In particular, data in the literature report deficits in pragmatic abilities, i.e. the use of language in a particular context (Levinson, 1983), leading to substantial difficulties in handling communicative interactions in everyday life (Struchen, Pappadis, Sander, Burrows, & Myszka, 2011), and causing vulnerability, for example, in the process of returning to work (Rietdijk, Simpson, Togher, Power, & Gillett, 2013).

Following TBI, individuals often display inaccurate and confabulated speech (Hartley & Jensen, 1992), and a decreased coherence in discourse (Coelho, Grela, Corso, Gamble, & Feinn, 2005). Their conversation is often tangential, egocentric,

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and not adequate to the context (Hough & Barrow, 2003; Linscott, Knight, & Godfrey, 1996; Mcdonald, 1993; see also Tu, Togher, & Power, 2011). Excessive talkativeness, tactlessness, repetitiveness, and difficulties in maintaining the topic in group situations are also common impairments (Coelho, 2007; McDonald, Code, & Togher, 2000). Furthermore, patients with TBI also experience difficulties in narrative discourse (Marini, Zettin, & Galetto, 2014) and turn-taking (Murphy, Huang, Montgomery, & Turkstra, 2015). The severity of the trauma seems to have an impact on patients' discourse productivity, although a generalized impairment can be observed despite the gravity of the lesion (Marini, Zettin, Bencich, Bosco, & Galetto, 2017). Following a TBI, especially when this is severe, individuals often find it difficult to go beyond the literal meaning of utterances and make inferences about the speaker's intended meaning, as in the case of comprehension of sarcasm (Channon & Watts, 2003; McDonald & Pearce, 1996; McDonald, Fisher, Flanagan, & Honan, 2015), deceit (Angeleri et al., 2008; Bosco, Angeleri, Sacco, & Bara, 2015) or humor (Braun, Baribeau, Either, Daigneault, & Proulx, 1989; Docking, Murdoch, & Jordan, 2000). Patients may also have difficulty in producing requests (Dardier et al., 2011; McDonald, 1993) or in providing the interlocutor with enough information to be understood (McDonald & van Sommers, 1993).

The ability to communicate through gestures may also be impaired after traumatic brain damage of different degrees of severity, as well as the ability to connote the speech with appropriate cues such as tone of voice, prosody, and rhythm (for a recent review see Ilie, Cusimano, & Li, 2017). Difficulty in decoding the prosodic aspects of speech (Joanette & Brownell, 2012), makes it hard for individuals with TBI to fully understand and disambiguate utterances (Marquardt, Rios-Brown, Richburg, Seibert, & Cannito, 2001). Moreover, difficulties in emotion recognition (Byom & Turkstra, 2012) and in social appropriateness (Dahlberg et al., 2006; Turkstra, McDonald, & DePompei, 2001) seem to have a negative impact on social reintegration and participation following TBI.

In addition to the communicative deficit, the well-known impairment in a number of cognitive domains, such as memory, attention, spatial orientation, and problem solving may also be responsible for a large part of the negative outcomes (Taylor et al., 2002b; Zhang et al., 2001). In particular, despite the heterogeneity of the pattern of impairment depending on the site and type of brain damage, individuals with TBI often report deficits in terms of executive functions, representing the ability to manage goal-directed behaviors (Miyake, Emerson, & Friedman, 2000): such difficulty relates to self-regulation and planning skills, and an executive impairment may have a central role in the management of activities of daily living (Godbout & Doyon, 1995), with a significant impact on the communicative abilities themselves (Channon et al., 2007; Douglas, 2010).

A fully developed Theory of Mind (ToM), the ability to infer other people's and one's own mental states and behave accordingly (Premack & Woodruff, 1978), seems to be necessary to communicate effectively (Brizio, Gabbatore, Tirassa, & Bosco, 2015; Sperber & Wilson, 2002; Tirassa, Bosco, & Colle, 2006) and several studies (Bosco & Gabbatore, 2017a; 2017b; Bosco, Bono, & Bara, 2012; Carotenuto et al., 2017; Cummings, 2015) have established a link between these two cognitive abilities. Performance on ToM tasks is often poor in individuals with TBI (Bibby & McDonald, 2005; Geraci, Surian, Ferraro, & Cantagallo, 2010) and such impairment might contribute to explaining the communicative-pragmatic impairment described above (Bosco, Parola, Sacco, Zettin, & Angeleri, 2017; Cummings, 2017; Happé, Brownell & Winner, 1999; Havet-Thomassin, Allain, Etcharry-Bouyx, & Le Gall, 2006; Martin & McDonald, 2003).

Many different clinical approaches and intervention programs have been proposed to overcome the communicative difficulties of individuals with TBI. These programs vary widely in the areas they address, as well as in their format and structure (see Finch, Copley, Cornwell, & Kelly, 2016). For example, Dahlberg and colleagues (2007) presented a group-based training characterized by emphasis on self-awareness and self-assessment; after the training and in a follow-up assessment, participants exhibited an improved ability to effectively manage conversation, with better turn-taking, cohesion, and clarity of expression. Kirsch and colleagues (2004) applied an assistive-technology intervention to individuals with TBI, with the aim to reduce verbosity and lead to more efficient communicative interactions; the intervention was shown to successfully modify the target behaviors, with a reduction in unnecessary utterance length. Other treatments were developed to improve social perception (e.g., McDonald et al., 2008) and emotion recognition (see Bornhofen & McDonald, 2008), but they only led to modest improvements in the target communicative behaviors. Finally, a number of rehabilitation programs included active training of significant others, who were instructed on how better respond to individuals with TBI during daily routines (e.g., Bellon & Rees, 2006; Togher, McDonald, Code, & Grant, 2004) so as to improve patients' self-perceived communication competence. The importance of both individual-centered and group treatments in the treatment of social communication remediation following TBI, has been recently highlighted by an international panel of experts (Togher et al., 2014).

The aim of the present study was to assess the efficacy of the Cognitive Pragmatic Treatment program (CPT) in improving functional communication abilities in individuals with chronic TBI, extending previous findings (Gabbatore et al., 2015). Compared with other rehabilitative approaches, the CPT has the advantage of including all the main aspects of communicative ability within a single program; in particular, the CPT does not focus exclusively on the linguistic component of communication, but extends to the use of gestures, facial expressions, and body postures, as well as to prosodic cues, such as rhythm and

intonation. The rehabilitative activities included in the CPT aim at increasing participants' inferential abilities, which are crucial to fill the gap between what it is said and what it is meant; moreover, particular emphasis is given to the ability to accurately match linguistic statements with adequate paralinguistic cues, such as tone of voice, facial expressions and body movements. Finally, the CPT includes targeted activities aimed to improve participants' ability to modulate their communicative acts depending on the particular social context in which the interaction is performed. The efficacy of the CPT has been first confirmed in a group of patient with TBI (Gabbatore et al., 2015), and later in a group of patients with schizophrenia (Bosco, Gabbatore, Gastaldo, & Sacco, 2016). There is evidence that the CPT modified the brain networks underlying the communicative processes that were specifically trained during the program (Gabbatore et al., 2017; Sacco et al., 2016).

The present study extends previous findings reported in Gabbatore and colleagues (2015) by increasing the number of participants with TBI and introducing an additional assessment tool to evaluate the efficacy of the CPT, the Communicative Abilities in Daily Living battery (CADL-2; Holland, Frattali, & Fromm, 1999). The CADL-2 complements the Assessment Battery for Communication (ABaCo; Angeleri, Bosco, Gabbatore, Bara, & Sacco, 2012; Bosco, Angeleri, Zuffranieri, Bara, & Sacco, 2012), which has already been used in the previous study.

Specifically, in the current study we aimed to (a) test whether the communicative skills of patients with TBI improved after the CPT program, as assessed by the equivalent forms of the Assessment Battery for Communication (ABaCo; Bosco, Angeleri et al., 2012) in line with previous results of (Gabbatore et al., 2015); (b) assess the efficacy of the CPT program using the Communicative Abilities in Daily Living test (CADL-2; Holland et al., 1999); (c) assess the correlation between patients' performance on communication tasks in the ABaCo and in the CADL-2, in both the pre- and post-treatment phase. Finally, we assessed patients' performance in a battery of cognitive tests in the pre- and post-treatment phase, in order to (d) explore possible improvements in cognitive functioning. Such cognitive improvements may be associated with enhanced communicative performance, considering that in recent years several authors observed a relation between communicative performances and cognitive abilities such as attention, memory, planning, cognitive flexibility, logical reasoning and ToM (Bosco et al., 2017; Cummings, 2017; McDonald et al., 2017); for a meta-analysis see Rowley, Rogish, Alexander, and Riggs (2017).

Material and Methods

Participants

Twenty-three participants were enrolled through the collaboration with Centro Puzzle in Turin (Italy), a rehabilitation center for brain-injured individuals. Four patients were not able to complete the rehabilitation program due to personal and health problems that were unrelated to the TBI. Thus, the final sample of patients who completed the Cognitive Pragmatic Treatment program was made up of 19 individuals (3 females, and 16 males), ranging in age from 22 to 58 years ($M = 38.5$; $SD = 10.8$) and with between 5 and 18 years of education ($M = 10.1$; $SD = 3.3$). At the time of the study all the patients were in a post-acute phase, at least one year after sustaining the injury (range in months: 16–312; $M = 99.4$; $SD = 88.3$), and they were living at home with their partners or relatives. All the patients had sustained a severe TBI, as borne out by the scores obtained on the Glasgow Coma Scale in the acute phase (equal to or less than 8). The cause of the brain injury was, in the majority of cases, a road traffic accident. The inclusion criteria were: (1) to be aged at least 18 years; (2) to be at least 12 months after injury; (3) to be Italian native speakers; (4) to have adequate receptive linguistic skills, certified by the achievement of a cutoff score of >29/36 on the Token test (De Renzi & Vignolo, 1962); and (5) to have impaired communicative pragmatic abilities as resulting from the administration of form A of the Assessment Battery for Communication (ABaCo; Bosco, Angeleri et al., 2012), in comparison to the normative performance of healthy controls (Angeleri et al., 2012). As a final point, only patients who attended at least 60% of the sessions were included in the study. However, participants had an overall attendance rate of 93%. The exclusion criteria were: (1) neuropsychiatric illness (e.g., schizophrenia or depression), (2) premorbid alcohol or drug addiction and (3) a prior history of TBI or other neurologic disease. All the information concerning the participants' clinical profiles was collected via their medical records (Please note we decided to exclude individuals with premorbid alcohol or drug addiction for the following reasons: (a) to reduce the possibility of cognitive and pragmatic deficits being attributable to substance abuse, more than to post-injury; (b) to reduce the rate of drop-out of patients during the treatment; (c) to reduce heterogeneity in the experimental groups, and thus increase the internal validity of the study. The exclusion of patients with drug or alcohol dependence may reduce the generalizability of our findings to comorbid patients suffering from both premorbid alcohol or drug addiction problems, but we considered the above-mentioned reasons sufficient to motivate the adoption of such exclusion criteria). The present research project was approved by the local ethics committee of the Centro Puzzle (Protocol C.E. No. 3, code ABACO), and all the participants provided their written informed consent to participate in the study.

The Cognitive Pragmatic Treatment Program

Cognitive Pragmatic Treatment (CPT) is a group training program composed of 24 sessions, each lasting about one and a half hours, with a break. The program is planned so that groups of 5/6 participants meet twice a week for 12 weeks, led by a psychologist. Each training session focuses on a specific aspect of communication, i.e., language, use of gestures, paralinguistic cues, social appropriateness, and conversational abilities; moreover, some sessions address theory of mind and planning ability as well as self-awareness, components which have a role in the structuring of efficient communicative interchanges. See Appendix A for an outline of the CPT sessions and Appendix B for an example of the structure of a rehabilitation session.

Regardless of the different topics covered during each meeting, the general aim of each session is to provide the patients with an ecological setting where they can practice their communicative abilities and learn how to deal efficiently with the problems they encounter during their daily activities. Both comprehension and production activities are taken into consideration through the use of videos, role-playing and specific activities for each communicative modality. Such activities are designed to increase patients' inferential abilities and help them to fill the gap that often occurs between the literal and the intended meaning in everyday life communicative interactions (consider, for example, the case of indirect speech acts, irony, metaphors, and other forms of figurative language, communicative implicatures and so on). Furthermore, the treatment is focused on increasing patients' ability to maintain attention and to use all the available expressive modalities, i.e. linguistic, non-verbal/extralinguistic (for example, gesture, facial expressions, body movement) and paralinguistic (prosody, tone and rhythm of the voice, and so on). Lastly, self-monitoring and feedback provided by the therapist and the other members of the group guide the patients throughout the process.

Each session is organized in several distinct phases: (a) *Introduction* to the content of the session, with an explicit reference to daily life episodes where the topic of the session plays a role. (b) *Comprehension activities*, mainly consisting of videotaped scenes, created ad hoc for the present training program, in which the patients can observe two actors interacting through the specific communication modality on which the session is based (i.e., the linguistic modality in linguistic sessions or the gestural modality in extralinguistic sessions, and so on). At the end of each video, the participants are invited to comment on the interactions they have observed, for the purpose of stimulating their comprehension of the proposed communicative situations portrayed. Such discussion is also aimed at improving discourse coherence and enhancing compensatory communication strategies. (c) *Production activities* are mainly based on role-playing activities (i.e., interactive scenarios reproducing everyday situations), where patients are required to conduct in-group conversations, with the aim of developing their ability to use contextual elements. Such activities also provide the patients with specific communication strategies and feedback in a protected setting. Other production activities are based on the ability to enhance various aspects of communication, such as the ability to adequately use facial expressions and prosodic elements to connote speech. (d) *Conclusion and "homework"* give the patients the opportunity to practice and reinforce the aspects of communication addressed during each session. For *homework* the patients are invited to pay particular attention over the following week to those interactions that take place during their daily communication activities which are similar to the ones discussed during the session. For example, someone who says something literally that does not exactly correspond to what he/she actually means to communicate, or someone who says something when meaning the opposite according to his/her non-verbal or paralinguistic means of expression, and so on. At the beginning of each session, the participants are invited to discuss, within the group setting, what they have observed during the past days in terms of whether they were able to efficiently manage such communicative interactions. See Bosco and colleagues (2016), Gabbatore and colleagues (2017), Gabbatore and colleagues (2015), Sacco and colleagues (2016) for a more detailed description of the structure of the CPT and the content of each rehabilitation session.

Assessment Measures

Communicative-pragmatic abilities. Patients' communicative-pragmatic abilities were investigated, before and after the training program, with the e*quivalent forms of the Assessment Battery for Communication* (ABaCo; Angeleri et al., 2012; Bosco, Angeleri et al., 2012).

The ABaCo has shown good internal consistency, good construct validity, and high interrater agreement (Sacco et al., 2008). Furthermore, Angeleri and colleagues (2012) provided norms for the nine scales composing the ABaCo, based on a sample of 300 healthy individuals of different educational levels, age, and sex.

The ABaCo is made up of items based either on short videos or vis-à-vis interaction, designed to assess communicative-pragmatic abilities in comprehension and production, covering a wide range of pragmatic phenomena. Moreover, the equivalent forms of the same tool, which are made up of items of the same level of difficulty but with different content, allow test and re-test procedures to be run in order to reduce any memory or learning bias. The battery is organized in four scales: Linguistic, Extralinguistic, Paralinguistic, and Context.

The *linguistic scale* assesses the comprehension and production of communicative phenomena, expressed using the linguistic modality (basic communication acts, sincere communication acts, deceit, irony). The same kinds of phenomena are assessed on the *extralinguistic scale*, where the communication acts are, instead, expressed using gestures. The *paralinguistic scale* assesses the comprehension and production of those aspects that generally accompany communication acts, such as gesticulation, facial expression, and prosody. This scale includes basic communication acts, communication acts expressing an emotion, and paralinguistic contradiction. The *context scale* assesses the adequacy of a communication act with respect to the discourse norms (i.e., Gricean maxims) and social norms. Tasks are scored on a two-point scale (0 = incorrect answer, 1 = correct answer). See Angeleri, Gabbatore, Bosco, Sacco, and Colle (2016), Bosco, Angeleri, Colle, Sacco, and Bara (2013), Parola and colleagues (2016) for a more detailed description of the administration and scoring procedures.

Functional communication abilities. Patients' functional communication abilities were assessed before and after the training program using the *Communication Activities of Daily Living* test (CADL-2; Holland et al., 1999). This standardized tool was used to assess changes in communicative performance following the CPT, and was administered before and after the training program to all participants. The CADL-2 has demonstrated a high degree of reliability: internal consistency (r = .93), test–retest (r = .85), and inter-rater (r = .99), furthermore it has shown high internal consistency (Cronbach's alpha: .93). The CADL-2 predicts global ratings of communication disorder and correlates strongly with the Western Aphasia Battery (Kertesz, 1982); it has been used in various studies to test the efficacy of communication therapies in individuals affected by aphasia (e.g., Aten, Caligiuri, & Holland, 1982; Carlomagno, Pandolfi, Labruna, Colombo, & Razzano, 2001; Cherney, Halper, Holland, & Cole, 2008; Hopper, Holland, & Rewega, 2002).

The CADL-2 measures the ability to use communication efficiently in role-play interactions and other simulated everyday contexts (for example, conversations at the doctor's office or while shopping at a store). The tasks included in the CADL-2 require participants to employ a range of both verbal and non-verbal communication skills; their responses are evaluated based on their effectiveness in conveying appropriate information in different contexts. The CADL-2 is administered in about 35 min, and the assessment is run using pictures and prompts to create appropriate contexts for the tested activities. The test is composed of 50 items, which investigate functional communication abilities in seven categories of communication activities:

– reading, writing and using numbers;
– sequential relationships;
– social interactions;
– divergent communication (responding to misleading information or proverbs);
– non-verbal communication;
– contextual communication;
– humor, metaphor, absurdity.

The items are presented in the form of role-playing activities, where patients are required to respond to real life scenarios, depicted by questions and pictures. For example, the patient is shown pictures depicting a doctor's office setting and some information is provided; patients are required to understand and remember the location and time of the appointment, describe the purpose of the visit and complete a form with personal details. As mentioned above, one of the distinctive features of the CADL-2 is that, for all the items, all modes of communication (i.e., gestures, speech, reading, and so on) are considered equally acceptable for conveying messages, and scoring is independent of the modality of the response that is provided. The CADL-2 uses a three-point scoring system, based on the observed communicative behaviors, which include social communication, requesting information, or correcting misinformation, and the responses can be coded as correct (2), adequate (1), or wrong (0).

For the purpose of this study, we adapted some of the material included in the original CADL-2 booklet. We modified some pictures used as prompts in order to make them more suitable for Italian participants and retain their ecological validity. For example, we replaced the picture of a distinctly American vending machine included in the booklet with a picture of an Italian vending machine, likewise, we replaced the original image of the button panel of an American elevator with an Italian one. Instructions and prompts were the same as in the original version of the test.

Neuropsychological and theory of mind assessment. Before and after the training program (at T1 and T2, respectively), a series of neuropsychological and ToM tests were administered to the patients in order to determine the functioning of ToM and of the main cognitive functions (i.e., attention, memory, planning, cognitive flexibility, logical reasoning).

Basic linguistic abilities were assessed with the denomination scale of the Aachener Aphasie test (Huber, 1983). Attentional abilities were assessed with the Attentional Matrices (Spinnler & Tognoni, 1987) and Trail Making tests (Reitan, 1958). Short-term verbal and spatial memory were assessed with verbal span and Corsi's Block-Tapping test (Spinnler, & Tognoni, 1987), respectively; moreover, verbal long-term memory was assessed using the immediate and deferred recall test for long-term verbal memory (Spinnler, & Tognoni, 1987). Planning skills were investigated using the Tower of London test (Shallice, 1982); cognitive flexibility was assessed with the Modified Card Sorting test (Nelson, 1976) and logical reasoning with the Raven Colored Progressive Matrices test (Raven, 1947). Theory of Mind abilities were measured using the Sally & Ann test (Wimmer & Perner, 1983) and a selection of Strange Stories tasks (Happé, 1994). The test scores were corrected for educational level and age, according to the Italian norms of each test.

Study Design, Training, and Procedures

The Cognitive Pragmatic Treatment program lasted 3 months. Patients' pragmatic, functional and cognitive abilities were assessed one week before (T1 – Pre-training) and one week after (T2 – Post-training) the rehabilitation program (see the *Neuropsychological and Theory of Mind assessment* paragraph). Moreover, the ABaCo was also administered to patients at T0 – Baseline, three months before starting the treatment, in order to control for any improvement in their communication skills that could have been a consequence of non-specific activities or due to spontaneous recovery. Such control procedure was necessary in order to rule out the impact of participation in activities other than the CPT program on improvements in patients' performance on communication tasks. Between T0 (Baseline) and T1 (pre-training) the patients followed their usual treatment programs, consisting in activities not specifically focused on communication (e.g., memory and attention activities at group and individual level, socializing and creative activities such as reading newspapers, cooking, and painting); patients attended such activities twice a week for the same number of hours as those dedicated to our training program. Such control procedure served to demonstrate the absence of any improvements in patients' communication skills that could have been a consequence of non-specific activities or due to spontaneous recovery. To complete the investigation, the ABaCo was administered again three months after the end of the rehabilitation program in order to verify the stability of the improvements in patients' communication skills after the end of the training program (T3).

The whole project lasted 9 months. See Fig. 1.

Results

Communicative-Pragmatic Performance

We examined differences in the communicative performance of individuals with TBI before and after treatment using a repeated-measures analysis of variance (ANOVA), entering their overall performance on the ABaCo as the dependent variable with Time (four levels: T0, T1, T2, and T3) as the within-subjects fixed factor. The results showed a main effect of Time ($F_{(3,48)} = 16.83$, $p < .001$, $\eta^2_p = .51$), indicating that communicative performance of individuals with TBI varied during the different times of the experimental design (ABaCo mean). To examine these differences we performed pairwise comparisons with Bonferroni correction, which showed that differences in performance on the ABaCo between T0 (baseline) and T1 (pre-treatment) were not significant ($p = .628$). The comparison of performance on the ABaCo between T1 (pre-treatment) and T2 (post-treatment) was significant ($p < .001$). The comparison of performance on the ABaCo between T2 and T3 revealed no differences ($p = 1.0$). See Fig. 2.

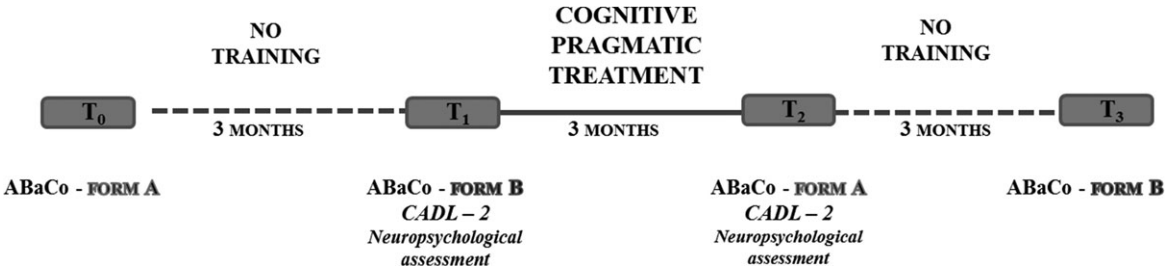

Fig. 1. Timeline of the study.

A comparison with ABaCo normative scores revealed that before the training (T1) eight patients (42%) obtained a score 2 *SD* below the ABaCo normative score for the corresponding educational and age level, while after the CPT (T2) only three patients (16%) still exhibited a score 2 *SD* below the ABaCo normative values. For a comparison with ABaCo normative scores see Tables 1 and 2.

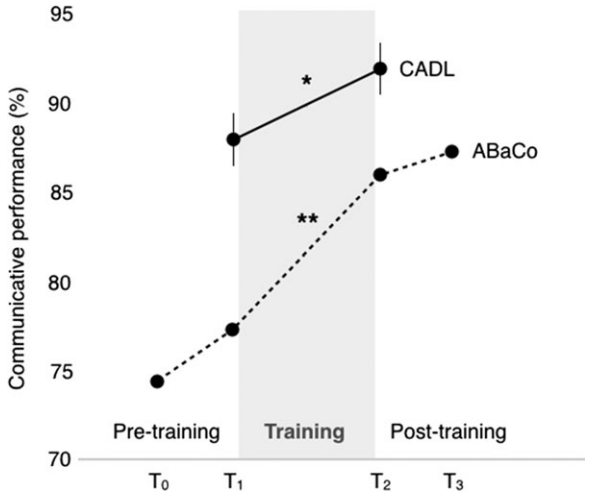

Fig. 2. Communicative performance (% of correct responses) on the ABaCo (T0: 74.8 (10.9); T1:A77.4 (10.4); T2:86.2 (7.3); T3: 86.6 (7.1)) and on the CADL-2 (T1: 88.4 (6.7); T2: 91.8 (6.6)) before and after training.

Table 1. Patients' performance on the ABaCo before and after the CPT and normative scores for the corresponding age range and educational level

ID	Normative ABaCo scores	T1 Pre-training	T2 Post-training
TBI_01	*.89 (.06)*	.86	.93
TBI_02	*.89 (.06)*	.72	.82
TBI_03	*.89 (.06)*	.92	.92
TBI_04	*.89 (.06)*	.79	.89
TBI_05	*.91 (.05)*	.83	.95
TBI_06	*.91 (.05)*	.53	.85
TBI_07	*.89 (.04)*	.95	.96
TBI_08	*.88 (.08)*	.85	.86
TBI_09	*.88 (.06)*	.77	.85
TBI_10	*.88 (.06)*	.64	.93
TBI_11	*.88 (.06)*	.63	.86
TBI_12	*.88 (.06)*	.74	.76
TBI_13	*.88 (.06)*	.77	.73
TBI_14	*.88 (.06)*	.72	.73
TBI_15	*.88 (.06)*	.70	.77
TBI_16	*.89 (.05)*	.81	.90
TBI_17	*.91 (.03)*	.77	.87
TBI_18	*.87 (.06)*	.82	.91
TBI_19	*.87 (.06)*	.89	.90

Table 2. Percentage of patients who scored two standard deviation below the normative scores of the ABaCo, or within the normative limits, for the corresponding age and educational level, pre- and post-CPT

	Pre-training	Post-training
Below Normative Scores	8 (42%)	3 (16%)
Within Normative Scores	11 (58%)	16 (84%)

Table 3. Patients' performance, before and after treatment, on neuropsychological and ToM tasks

Neuropsychological test	Cognitive function	T1 – Pre-treatment score[a]	T2 – Post-treatment score[a]	*T*-value	Level of significance
Aachener Aphasie test	Basic linguistic abilities	111.37 (9.44)	114.26 (5.13)	−1.26	.22
Attentional Matrices	Attentional abilities	37.38 (8.19)	36.66 (8.81)	0.43	.68
Trail Making test (B-A)[b]		54.41 (33.35)	67.65 (32.79)	−1.45	.17
Verbal span	Short-term memory	3.50 (0.5)	3.83 (0.78)	−2.1	.045
Corsi's Block-Tapping test		4.63 (0.86)	4.72 (1.06)	−0.35	.73
Immediate and deferred recall test	Long-term verbal memory	8.46 (3.42)	10.01 (2.91)	−1.84	.084
Tower of London test	Planning capacities	23.58 (4.79)	24.52 (5.06)	−0.94	.36
Modified Card Sorting test	Cognitive flexibility	37.10 (8.03)	40.68 (6.62)	−3.35	.004
Raven Colored Progressive Matrices	Logical reasoning	28.16 (4.78)	29.31 (4.12)	−2.09	.051
Sally & Ann	Theory of Mind	90 (32)	80 (42)	−0.58	.59
Strange Stories		4.16 (1.42)	4.53 (1.39)	−1.51	.15

[a]Education- and age-corrected scores, according to the Italian norms.
[b]The score is given by the equivalent point, i.e., standardized 5-level scores.

Functional Communicative Performance

The differences in performance by individuals with TBI on the CADL-2 test, before and after the treatment program, were analyzed using a paired-sample *T*-test. Individuals with TBI showed an improvement in their functional communication abilities ($t = 2.47$, $p = .024$) after the treatment. See Fig. 2.

Relations between the ABaCo and the CADL-2

To examine the relationship between performance on the ABaCo and CADL-2 tasks, we used the Pearson's product–moment correlation coefficient. In particular, we explored correlation in performance on the ABaCo pre-treatment test (the mean of T0 and T1) with performance on the CADL-2 pre-treatment test (T1), and performance on the ABaCo post-treatment test (the mean of T2 and T3) with performance on the CADL-2 post-treatment test (T2). The results showed a positive correlation between the scores on the ABaCo and CADL-2 tests administered both pre-treatment ($r = .52$, $p = .022$) and post-treatment ($r = .59$, $p = .007$).

Neuropsychological and Theory of Mind assessment

To examine differences in cognitive performance of individuals with TBI before and after the treatment program, we performed a series of paired *T*-tests. We found that individuals with TBI showed improved performance on the tasks in the subsequent neuropsychological test, Verbal span test ($t = 2.15$, $p < .05$), and Modified Card Sorting test ($t = 3.35$, $p < .05$). All the other differences were not significant ($.43 < t < 2.09$; $.051 < p < .73$). See Table 3.

Discussion

The aim of the present study was to verify the efficacy of the Cognitive Pragmatic Treatment program (CPT, Gabbatore et al., 2015) in improving communicative abilities of patients with TBI. We examined the difference in patients' communicative-pragmatic performance before and after administering the treatment. First of all, we did not detect any spontaneous improvement in patients' performance on the ABaCo tasks at baseline (T0) compared to the pre-treatment (T1) assessment. In contrast, a significant improvement was observed in patients' communicative-pragmatic performance after the CPT program. Before the CPT, 42% of patients showed scores which were 2 *SD* below the ABaCo normative scores for the corresponding educational and age level, while after the CPT only 16% of patients still presented a score 2 *SD* below the ABaCo normative values. In line with Gabbatore and colleagues (2015), we confirmed the efficacy of the CPT in improving patients' communicative-pragmatic ability after traumatic brain injury. The improvements persisted in the follow-up phase (3 months after the end of the treatment), indicating that gains in communicative performance were stable over time. The efficacy of the CPT was further supported by the analysis of CADL-2 scores, as patients showed significantly higher performance in the post-treatment phase.

The results of the present study showed that chronic patients with TBI may be able to improve their communicative performance even years after the injury occurred. The possibility of detecting improvements even years after the TBI occurs is in line with recent studies in individuals with chronic TBI (Sacco et al., 2016) as well as with schizophrenia (Gabbatore, Bosco et al., 2017), showing the effect of CPT in promoting brain plasticity (see also Nudo (2011) for a review on brain plasticity after brain injury). These results dovetail with previous evidences regarding the effectiveness of specific treatments in improving the psychosocial functioning of patients with TBI (Bornhofen & McDonald, 2008; Dahlberg et al., 2007; Kirsch et al., 2004; see also Finch et al., 2016). Of particular interest in this regard was the present analysis of the CADL-2, which measures the ability to efficiently use communication and convey appropriate information in everyday contexts. Some evidence in the literature (Cruice, Worrall, Hickson, & Murison, 2003) indicates a correlation between communicative performance on the CADL-2 and measures of health-related quality of life, supporting the idea that the communicative abilities assessed by the CADL-2 have an impact on the effective management of everyday activities and interactions. Following this line of reasoning, the positive outcomes observed after the CPT program may plausibly generalize to patients' everyday life: for example, the ability to understand non-literal communication, maintain attention, use multiple expressive modalities (including non-verbal/extralinguistic and paralinguistic cues), and adjust the content and the style of communication to a particular context, may contribute to better re-integration into social environments (see Hofgren, Esbjornsson, & Sunnerhagen, 2010; Rietdijk et al., 2013; Struchen et al., 2011; Ylvisaker, Turkstra, & Coelho, 2005). Indeed, some studies have suggested that communicative outcomes play an important role in facilitating reintegration into the work environment for individuals with TBI (Douglas, Bracy, & Snow, 2016). Moreover, Struchen and colleagues (2011) pointed out that social communication abilities, together with affective/behavioral functioning, have a significant role in terms of social integration for these individuals.

Furthermore, our results showed a correlation between patients' performance on the ABaCo and on the CADL-2, both in the pre-treatment and post-treatment phases. Such results indicate a convergent content validity between the two tools in revealing patients' communicative deficit (before-treatment) and their improvement (after-training).

In order to investigate the possible role of cognitive functions in the improvement of patients' communicative abilities, we also investigated whether any differences could be detected in patients' performance on cognitive tasks before and after treatment. We only observed higher scores obtained in the Verbal span and Modified Card Sorting tests, assessing working memory, shifting and inhibition, respectively. Differences in all the other cognitive domains investigated, i.e. attention, spatial memory, long-term memory, planning and ToM, were not significant. We were not surprised to that, as a collateral effect of our training program, working memory, shifting and inhibition improved, since these cognitive abilities were indirectly solicited during the training activities. For example, during the CPT rehabilitation sessions, the patients were asked to keep their attention on what was being said in the video clip used during the treatment, and they were also asked to inhibit inappropriate answers. However, such results need to be interpreted with caution, because of the possible role of a practice/learning effect and the multiple comparisons procedure. Even though the tasks were repeated three months after they were first presented, it is still difficult to rule out the possibility that the improvement we observed might have been due to a practice/learning effect: patients could have benefited from a form of facilitation when performing the task for the second time. To summarize, we observed that performance in the communicative tasks included in the ABaCo and CADL-2 improved after the CPT program, while scores of most of the neuropsychological tests did not (with the exception of the Verbal span and Modified Card Sorting tests). These findings support the specificity of the CPT program, which focuses on communicative-pragmatic abilities rather than general cognitive skills.

In interpreting the results of this study, some limitations must be considered. First, the study lacked a control group; however, a within-subjects design with multiple pre- and post-treatment assessments was employed to evaluate the effect of treatment. A 3-month baseline condition during which participants took part in their usual rehabilitation activities (between T0 and T1) was followed by a 3-month CPT program (T1–T2), ending with 3 months of during which patients went back to rehabilitation as usual (T2–T3). Using the ABaCo equivalent forms to evaluate participants' pragmatic abilities, we only detected a significant improvement in their communicative abilities between T1 and T2, i.e., specifically after the CPT program had been administered. Thus, even in the absence of a control group, our results indicate that there was a specific effect of the CPT program on the participants' communicative abilities, while there was no improvement during their usual cognitive and motor rehabilitation training either before or after the treatment. Second, the small sample size limits the extent to which results can be generalized; future studies will increase the number of participants in order to replicate and extend the current findings. Finally, our sample was not balanced by gender, and the number of female was too small to allow meaningful comparisons with male. In a larger study, it would have been interesting to explore gender differences in the efficacy of the treatment, as studies have consistently shown that men tend to experience better outcomes after brain injury compared to women (e.g., Bazarian, Blyth, Mookerjee, He, & McDermott, 2010; Di Carlo et al., 2003; Farace & Alves, 2000).

Conclusions

To conclude, the present results provide further evidence about how individuals with TBI benefit from taking part in a training program focused on improving their communicative skills. Indeed, the encouraging outcomes of such training program seem to have a potential positive effect on daily communication activities, at least as testified by their improved performance on the CADL-2, even for patients who are in the chronic phase post-injury and also in the absence of specific linguistic deficits.

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Conflict of Interest

None declared.

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Appendix A

Outline of the CPT program rehabilitation sessions

Session 1:
Awareness of the deficit
Introduction to the aims and tools of the CPT program; construction of the clinical setting; self-presentation of each patient including own communication difficulties and expectations.

Sessions 2 & 3:
General communicative ability: an overview
Video-clips and role-playing focused on overall pragmatic effectiveness expressed through all the modalities constituting communicative competence.

Sessions 4 & 5:
Linguistic ability
Video-clips and role-playing based on the linguistic expressive modality.

Sessions 6 & 7:
Extralinguistic ability
Video-clips and role-playing based on the gestural modality.

Sessions 8, 9 & 10:
Paralinguistic ability

Video-clips, facial expression recognition, tone of voice tasks, role-playing; Picture of Facial Affect (POFA; Ekman & Friesen, 1976), and JACfee and JACneuf (Matsumoto & Ekman, 1988); JACbart (Matsumoto et al., 2000), and Eyes Task-Adult (Baron-Cohen et al., 1997); Cohn-Kanade Database (FACS model; Kanade et al., 2000), grammelot.

Sessions 11 & 12:
Social appropriateness ability
Video-clips and role-playing focused on social appropriateness and communicative adequacy in different contexts.

Sessions 13 & 14:
Conversational ability
Video-clips, role-playing and Tangram exercises focused on the use of conversational rules (i.e., turn-taking topic management).

Sessions 15 & 16:
Management of telephone conversation
Audio-clips and role-playing focused on telephone conversational rules (i.e., no possibility of taking advantage of the paralinguistic and gestural elements which usually connote communicative interactions).

Sessions 17 & 18:
Planning ability
Individual and group sub-goal task activities, (e.g., planning household chores).

Sessions 19 & 20:
Theory of mind
Video-clips and role-playing focused on the ability to formulate meta-representations with respect to one's own and others' mental states.

Session 21:
Narrative ability
Description tasks (Brookshire & Nicholas, 1997) and speech elicitation pictures (WAB; Kertesz, 1982) to elicit story-telling, providing an adequate amount of information.

Sessions 22 & 23:
General communicative ability: a summing-up
Video-clips and role-playing focused on the overall pragmatic effectiveness expressed through all the modalities constituting communicative competence.

Session 24:
Post-training awareness
Conclusions and feedback about progress made, compared to each patient's initial video-recorded performance.

Appendix B

Session 6 – Extra-linguistic ability: Example of a rehabilitation session

Today's session: introduction of the topic and recap	Explicit reference to daily life situations where the topic of the session plays an important role. Brief summary of what has been done in the previous sessions.
Comprehension activities	Use of videos created ad hoc for the purpose of the CPT. In each video, two actors interact using the specific communication modality on which the session is based (i.e. mainly through language in linguistic sessions, mainly through gestures in the extralinguistic session and so on). The actors participating in the production of the videoclips included in the equivalent forms of the ABaCo are different from those involved in the videoclips used within the CPT. This allows to exclude any possible facilitating or confounding effect. The videos used during the CPT regard different kinds of communicative situations: • Complex communicative interchanges, such as ironic or deceitful statements: *Example:* Roberta is dusting the bookcase in her living room. While she is moving books to clean better, a whole row of books falls down onto the floor. Luca, who was in the living room, concentrating on his own activities, looks ironically at Roberta and makes a gesture with his hand as if to say "Great job!" • Communicative failures, where the actors do not achieve their communicative intents: *Example:* Luna is chatting with a friend on the phone. Her father passes close to her and throws his daughter a glance of reproach, glancing at the clock. Misunderstanding, Luna looks at her own watch and indicates to her father with her hand that it's half past four. • Successful communication. The video depicts the same situation as above, but in this case the actors understand their mutual intents: *Example:* Luna is chatting with a friend on the phone. Her father passes close to her and throws his daughter a glance of reproach, glancing at the clock. Then he passes close a second time and he makes a brusque sign pointing to the clock. Luna indicates to her father with her hand "Just one more minute". *Discussion* on the interaction depicted in the videos in order to stimulate the participants' comprehension of the presented situations, i.e. *What happened? Was the girl's behavior appropriate to the situation and to the request? Why? What could she have said?*. The discussion is also aimed at improving the participants' discourse coherence and facilitating their ability to interact with each other and to introduce compensatory communication strategies.
Production activities:	Use of role-playing activities devised for the specific purpose of the CPT, aimed at offering the participants the possibility of practicing their communication strategies and getting feedback in a protected setting. Participants are asked to conduct in-group conversations, in order to stimulate their ability to use contextual elements. Example: *Character 1*. You invited a friend of yours to your place for lunch. You really would like your friend to help you with setting the table and cooking. Indeed, you know very well that your friend is a slacker and you are definitely annoyed by his behavior. *Character 2.* You're a guest at your friend's house. As usual, you want to find some good excuses not to set the table or help with the cooking. As always, you hope to be able to enjoy a dinner without effort, thus you are ready to provide good excuses. *Discussion* on the communicative interaction observed in the role-playing activities.Moreover, specific sessions focus on enhancing various aspects of communication, such as the ability to recognize and correctly use facial expressions and prosody.
Conclusion and homework	In order to help the participants to practice and reinforce the aspects of communication addressed during the session in their daily living, some "homework" tasks are assigned at the end of each session. The participants are encouraged to pay attention to their communicative interactions in their daily living, with a particular focus on those communicative exchanges which are similar to the ones discussed during the session (i.e., someone saying something literally that does not correspond exactly to his/her own real communicative intentions, or someone who says something intending the opposite, as suggested by his/her non-verbal or paralinguistic means of expression). At the beginning of each session, the participants are requested to report and discuss with the other participants what they have observed and whether they were able to efficiently manage such communicative interaction. Moreover, specific homework tasks concerning particular aspects of communication (e.g., practical exercises on regulating tone of voice, and intonation) are provided.