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Cognitive Pragmatic Treatment: A rehabilitative program for Traumatic Brain Injury individuals

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Abstract

Objective: To verify the efficacy of Cognitive Pragmatic Treatment (CPT), a new rehabilitation training program for improving communicative-pragmatic abilities. **Design:** The CPT program consists of 24 group sessions, concerned with improving several communication modalities, Theory of Mind (ToM) and cognitive components that can affect pragmatic performance, such as awareness and executive functions. **Participants:** A sample of 15 adults with severe traumatic brain injury. **Main Measures:** Improvements were evaluated before and after training, using the equivalent forms of the Assessment Battery for Communication (ABaCo), a tool for evaluating comprehension and production of a wide range of pragmatic phenomena. A neuropsychological and ToM assessment was also conducted. **Results:** The patients' performance improved after training, in terms of both comprehension and production, in all the communication modalities assessed by the ABaCo, i.e. linguistic, extralinguistic, paralinguistic and social appropriateness abilities. The follow-up showed that the improvement of patients persists after three months from the end of the training. **Conclusion:** The results suggest that the CPT program is efficacious in improving communicative-pragmatic abilities in individuals with TBI, and that improvements at this level are still detectable even in chronic patients years after the injury.

Keywords: Traumatic Brain Injury; Communication; Pragmatics; Cognitive; Training

Introduction

The ability to interact and communicate with others effectively is essential in our society. This ability can be compromised following TBI, and it has been demonstrated that poor communication skills are a serious obstacle to community reintegration and personal autonomy[1,2]. Communication impairment refers not only to a linguistic deficit but involves social communication skills[3] and pragmatic aspects of communication, such as the use of language, gestures or prosodic cues to convey a specific meaning in a given context[4-7]. Communicative-pragmatic competence refers to a complex cluster of abilities that allow a person to understand the interlocutor's intended meaning, starting from the literal meaning of an utterance. Communicative-pragmatic deficits after TBI may include excessive talkativeness, poor topic maintenance, repetitiveness[8] and difficulties in starting and maintaining a conversation[9-12]. Patients with TBI may show impairments in the organization of narrative discourse[13], which may be long-winded, poorly organized and tangential[14]. They may have an impaired ability to understand sarcasm[15], irony[16] and indirect requests[17]. Moreover, these patients often exhibit low levels of social appropriateness during their communicative interactions; this means that they show insensitivity, poor social judgment and inadequate intimacy with their interlocutors[18]. The social communication impairment of these patients is also attributable to their impaired ability to understand the prosodic aspects of speech[19], recognize emotional prosody, i.e. the recognition of emotion based on prosodic cues[20], and specifically understand facial expressions[21].

TBI patients often have a damage in the frontal lobe, a brain area involved in executive function[22]. Executive functioning is a construct used to describe the goal- directed behaviour, including abilities such as attention, memory, cognitive flexibility, planning and self-monitoring. Such functions can be significant contributors to patients' communication deficits[23, 24]. In particular, there is evidence to support the hypothesis that impaired executive functions and Theory of Mind, that is the ability to ascribe mental states to oneself and the others and to use this knowledge to predict and explain the relevant actions and behaviors[25,26] play a role in explaining

communicative/pragmatic performance of patients with brain injury[27-30]. In particular, some authors[31] suggested that a rehabilitation program should take these factors – executive functions and ToM - into consideration, in order to improve patients' communicative abilities.

One of the key aims of rehabilitation in this field is to give individuals who have sustained a brain injury opportunities to acquire communication skills and to effectively use them in their life, with the final aim of maximizing functioning and foster independence. A rehabilitation program should not focus exclusively on the remediation of impairments, but should also reduce disability and help to restore social role functioning[32]. This is achieved by also focusing on patients' self-awareness, which can contribute to increasing their levels of motivation during rehabilitation[3] and by improving their ability to recognize their residual abilities and suggesting compensatory strategies[33].

Traditionally, treatment approaches in the communicative-pragmatic literature have focused therapeutic practice on the effective use of language in a given context; the first effective pragmatic rehabilitation program was *Functional Communication Treatment*[34], based upon the patient's involvement in simulated real-life settings through the use of non-verbal communication strategies. This clinical approach was later taken up in the *Conversational Coaching*[35] approach, aimed at stimulating patients' conversational abilities. Ehlrich and Sipes[36] went on to create a communication rehabilitation program, specifically for patients with TBI and based on the functional-pragmatic approach. The program used role-playing games and it was aimed at improving non-verbal communication, appropriate communication in a particular context, message repair and cohesiveness of the messages conveyed. Marshall[37], adopting the pragmatic approach, demonstrated the effectiveness of group therapy, focused on the ability to begin conversational exchanges and convey messages and on self-awareness about personal goals and progress made[38]. Improvements in social communication skills are achieved with both individual (e.g emotional perception training[39] and group treatments, targeting specific communication behaviors with individualized treatment goals, role playing, video-feedback, reinforcement, practice and self

monitoring[40, 3, 41, 42]. Moreover, the role of regular communication partners in improving everyday interactions of people with TBI was also recently underlined[43-45].

Both in a systematic review[46] and in the EFSN guidelines on cognitive rehabilitation[47] it has been claimed that overall empirical data support the effectiveness of functional-pragmatic therapies after TBI, though require further confirmation given the limited number of studies and small samples investigated. However, a more recent meta-analytic re-examination[48] did not support the efficacy of functional-pragmatic therapy in patients with TBI. It thus seems that further research in this domain is necessary (see also [49, 50]).

The aim of the present paper is to present, and verify the effectiveness, of a new rehabilitation program - Cognitive-Pragmatic Treatment (CPT) – developed to take into account the main components, i.e. executive functions, and ToM, related to communication competence and useful for reintegrating patients with TBI into their social environment. The novelty of the Cognitive Pragmatic Treatment is that it adopted a different theoretical perspective with respect those already existing in the literature, that is the Cognitive Pragmatic theory[51-55], focused on the cognitive and inferential processes underlying human communication. In addition to executive functions and ToM, the CPT also take into account a further factor useful in explaining communicative deficits in patients with TBI, that is inferential ability[5,56]. Inferential ability refers to a person's capacity to fill the gap that sometimes exists between what a person actually says (i.e. "Could you pass me the salt?") and what s/he intends to communicate (i.e. to obtain the salt and not really to know whether or not the partner is able to pass the salt). The convenience in adopting such framework is that it offers a useful theoretical base on which to explain communicative deficits in patients with TBI [4, 5].

According to the theory, a communication act can be conveyed through different modalities - words, gestures, body movements and facial expressions - which should be intended as different means for expressing the same communication competence[51- 53]. One of the relevant aspects of the theory, useful for the purposes of the present research, is that communication is conceived as a

process that requires different steps of elaboration. In more detail, according to the Cognitive Pragmatic theory, the process of comprehension and production of a communicative act occurs in a sequence of distinct inferential steps that allow a person to comprehend the interlocutor's intended meaning, starting from the literal meaning of an utterance.

1. Expression act. The partner recognizes what the actor communicated, starting from the literal meaning. Note that the use of the terms actor and partner - instead of speaker and hearer - was intended to highlight that the theory refers to both linguistic and extralinguistic communication.

2. Actor's meaning. The partner recognizes the meaning of the utterance when he reconstructs the actor's communicative intention.

3. Communicative effect. This represents the entire set of the partner's mental states acquired or modified as a result of the communicative intentions expressed by the actor.

4. Reaction and response: The partner decides how s/he wishes to respond to the actor as a result of the communicative act; and s/he thus produces an overt communicative response (an action or an utterance) in reply to the actor's communicative act.

Using this theoretical framework[56] conducted a fine-grained model for describing clinical observations concerning the severity of pragmatic deficits in participants suffering from TBI and described the extent of a deficit on the basis of an individual's difficulty with understanding/producing the expression act, or the actor's meaning, or the communicative effect. The identification of a specific level of impairment offered us some clinical suggestions regarding methods to improve the communicative efficacy of individuals affected by TBI. In our rehabilitation program we focused patients' attention on the fact that people who interpret what is said literally do not necessarily understand what the other person intended to communicate. We focused patients' attention on the fact that in order to fully comprehend what a person intends to communicate they must make the effort to consider other possible communicative meanings, with respect to what the interlocutor actually (literally) says.

Furthermore, another novelty of the present study is that, to our knowledge, this is the first time that equivalent forms[57] of the same test, the Assessment Battery for Communication[58,59] have been used to evaluate improvements in patients' communicative performance [60].

To summarize, we expected patients to show an improvement in their communicative-pragmatic skills after CPT, with regard to all the communication modalities taught during the rehabilitation sessions. In particular we focused on the following communication modalities: linguistic, that is a person's ability to convey communicative meaning through language; extralinguistic, that is a person's ability to convey communicative meaning through the use of gestures, facial expression and body postures; paralinguistic, that is a person's ability to convey communicative meaning through the use of voice – such as rate, pitch, volume- and prosodic cues, such as rhythm and intonation and conversational, that is the ability to manage turn taking and the theme of conversation. We also focused our training on social appropriateness, that is a person's sensitivity to the social context, such as the ability to answer in a polite manner to a kind request. Finally, we expected this improvement to persist after a follow-up period of three months.

Method

Participants

Twenty adult patients with TBI were recruited for the study. Five of the patients did not complete the rehabilitative program because of personal and health problems encountered during the study (e.g. one of the patients moved to an other town). Thus, the results of the present study are referred to a sample of 15 patients with TBI (5 females and 10 males) ranging in age from 22 to 51 years (M = 36.7 years; SD = 8.73 years); their level of education ranged from 8 to 16 years of schooling (M = 9.27 years; SD = 2.6 years). The sample of this study is representative of the Italian

population in terms of age and educational level, according to the Italian National Institute of Statistics (ISTAT) (see also [59])[1].

Participants with brain injury were recruited in a one-year lasting period with the help of Centro Puzzle, a local rehabilitation centre for patients following head and severe brain injury. The patients were divided into three rehabilitation groups, each composed of five individuals, according to the time of recruitment.

The time after onset ranged from 12 to 228 months (M = 76.13; SD = 60.76). All patients had sustained a severe TBI: their scores on the Glasgow Coma Scale in the acute phase had been equal to or less than 8 (see Table 1 for patients' clinical details). Brain lesions were identified through TC/RM scanning by a neuroradiologist. The majority of patients had sustained their injury in a road traffic accident. At the time of the study, all the patients were living at home; all were in a post-acute phase and none were living independently without a partner or parent.

The patients with TBI were included into the study if they were able to meet the following inclusion criteria: (1) be at least 18 years of age; (2) be at least at 12 months post brain injury, in order to establish that the cognitive profile was stable; (3) be Italian native speakers; (4) have adequate cognitive and communication skills, certified by the achievement of a cut-off score on the Mini Mental State Examination[61] (MMSE; cut-off 24/30) and Token Test[62] (cut-off 29/36) and (5) exhibit communicative-pragmatic deficits, as resulting from the administration of form A of the Assessment Battery for Communication[57] in comparison to normative performance by healthy controls[59]. (6) A minimum attendance rate of 60% at all therapy sessions was mandatory for inclusion in this study. Exclusion criteria were report of (1) neuropsychiatric illness and (2) pre-morbid alcohol or drug addiction; (3) prior history of TBI or other neurological disease. All the

[1] The Italian school system is organized as follows: primary school (lasting 5 years - from 6 to 11 years of age), secondary school (lasting 3 years), high school (lasting 5 years) and then University and further. Nowadays, schooling is compulsory up the age of 16 (10 years of schooling), nevertheless until 1993 the limit was 8 years of attending school.

information concerning the clinical profile of each participant were available via medical record. Patients attended the rehabilitative center as day-hospital or residential guests: this implied periodical medical examinations able to guarantee the health status of each patient. Beside, we could verify that none of the patients had sustained further injury or neurological event after the TBI we considered for this study; moreover we are able to ensure that none of the participants had been using alcohol or drugs at the moment of the study and that they had no history of substances addiction during their life-span. After screening, all the patients attending the rehabilitative center who met the criteria required by the study were included.

All the participants gave their written informed consent to participate in the study. Approval for the study had previously been obtained from the local ethics committee.

-Table 1 about here -

- Table 2 about here -

Experimental Design, Structure and Procedure of the Training

The study was conducted over a period of 9 months and comprised a 3-month training period and 4 experimental sessions, organized according to the ABAB design (see Figure 1).

T0_Baseline: Three months before the treatment started, the recruited patients were assessed using Form A of the ABaCo in order to delineate their communication abilities and impairments. *Control procedure to check for improvements due to non-communication activities:* After undergoing this assessment the patients attended twice weekly sessions, which lasted the same number of hours as our CPT and involved various activities not specifically focused on communication. These included: (a) memory and attention group and individual activities, (b) socializing activities, including group recreation and games activities and (c) intellectual and creative activities, such as reading the newspaper, cooking and painting. The purpose of this control

procedure was to test patients for any improvements in their communication skills due to spontaneous recovery, as a consequence of non-specific activities or simply owing to the fact that they were taking part in a research program.

T1_Pre-Training: The day before the treatment started, the patients' communicative performance was assessed again using Form B of the ABaCo, in order to obtain a measure of their abilities before embarking on the rehabilitation program and to verify the absence of any improvement due to the non-specific activities attended between T0 and T1. In order to have a further evaluation of the patients profile of functioning pre- and post treatment a neuropsychological and ToM tests battery was also administered to the patients (see Table 2),

T2_Post-Training: The day after the treatment ended, Form A of the ABaCo was administered to the patients in order to verify the efficacy of the training program on their communicative performance. Moreover, we conducted a post-training cognitive evaluation using the same neuropsychological and ToM tests used at T1.

T3_FollowUp: Three months after the end of the rehabilitation program, we administered Form B of the ABaCo to the patients, in order to verify the stability of their communicative performance in time.

-Figure 1 about here –

The Cognitive-Pragmatic Treatment program consists of 24 sessions; each session is concerned with training and enhancing one particular aspect of communication at a time. The treatment is provided in two sessions per week and lasts 12 weeks. Each session lasts approximately one and a half hours with a ten-minute break. Rehabilitation activities are performed in small groups of five patients led by a psychologist. Most of the treatment focuses on communication, regarding different expressive modalities, i.e. linguistic, extralinguistic, paralinguistic, social appropriateness and conversational abilities. Other rehabilitation sessions focus on other aspects related to communication and cognitive competences such as awareness, theory of mind, and

planning abilities. See Table 3 and Table 4 for a schematic representation of the training and a description of the general structure of the rehabilitative sessions, respectively. Moreover, a detailed description of the topics covered in each rehabilitative session is provided in Text, Supplemental Digital Content 1.

The rehabilitation treatment we proposed addresses pragmatic communicative competence as a whole, in terms of both comprehension and production. The program provides an ecological setting in which patients can practice their communication abilities and learn how to manage everyday communication problems through self-monitoring and feedback by the therapist. Unlike social skills training[3, 43, 71], our treatment is primarily focused on the mental representations underlying one's behaviors rather than on teaching patients how to handle everyday life situations. In everyday communication the intended meaning often does not simply correspond to the literal one, for example a person could say "What nice weather", meaning to be ironic and remarking on the fact that it is raining. The ability to manage the inferential processes needed to fill this gap is often compromised in patients with TBI [5,17]. Communication may be viewed as a process that involves different stages of elaboration, that from the literal meaning of an utterance allows a person to comprehend the communicative meaning intended by the partner (see the Introduction). The activities proposed during the training program are designed to increase patients' inferential abilities that allow them to fill the gap that sometimes occurs between what a person says and what s/he intends to communicate. In each session the discussions and exercises are focused on the communicative intentions observed rather than on the mere linguistic aspects of the utterances, which are quite well preserved in these patients. In particular, the patients were encouraged to go beyond the literal meaning of the utterances and focus on the speakers' communicative intentions, on the different meanings and implications a sentence can assume, depending on the specific situation and the surrounding context.

Moreover, particular emphasis is placed on the ability to adequately match linguistic utterances with appropriate paralinguistic aspects, such as the tone of voice, facial expressions and

body movements. The ability to manage the paralinguistic aspects of communication is, indeed, often impaired in individuals with TBI, who have difficulties both in accompanying their communication acts with appropriate paralinguistic cues and in understanding prosodic aspects of speech, especially when prosody would help in disambiguating utterances[20, 72]. Finally, the training is aimed at helping patients to modulate their communication according to a particular context. Communicative inappropriateness following TBI represents, in fact, an impressive obstacle to patients' social reintegration.

- Table 3 about here -

Each session was video-taped, with the participants' consent, to allow the experimenters to give a better analytical, critical and objective contribution to the contents of the sessions and also to help patients develop an awareness of their deficits and their progress, through video feedback during and at the end of the rehabilitation program.

Some examples of the material used are given in Text, Supplemental Digital Content 2.

-Table 4 about here –

Measures

Treatment effects were evaluated using the equivalent forms (A and B) of the Assessment Battery for Communication[57, 58]. Equivalent forms of the same test are useful tools in clinical practice and intervention research, when patients' performance needs to be tested at different times, before and after a rehabilitation program. They use test and retest procedures to provide a measure of treatment efficacy and reduce the possibility of patients' scores obtained during the retest assessment session being attributable to practice and memory, rather than representing an actual measurement of their progress. The equivalent forms of the ABaCo are made up of four different

evaluation scales - linguistic, extralinguistic, paralinguistic and context - which investigate all the main pragmatic aspects of communication. Each scale is, in turn, divided into comprehension and production tasks, thus each scale is composed of a *comprehension* and a *production* subscale respectively evaluating comprehension and production abilities in each communication modality. Each form comprises 68 items based on the examiner's prompts during a brief communicative interaction with the patient, or on brief videotaped scenes. Each videotaped scene lasts 20–25 s and comprises a controlled number of words (range: 7 ± 2), (for a more detailed description see [5, 56-59]).

Moreover, before (T1) and after the training program (T2), a series of neuropsychological and ToM tests (see Table 2 for a brief description of the aim and the procedure of each test) were administered to the patients in order to assess and establish the integrity or impairment of ToM and the main cognitive functions (i.e. attention, memory, planning ability, cognitive flexibility, logical reasoning) and to evaluate the effect of possible cognitive deficits in undermining patients' communication skills.

Coding procedures

The participants' answers on the ABaCo were coded off-line by two independent judges, blind with respect to the aims of the research. The level of agreement among raters was calculated using the Intraclass Correlation Coefficient (ICC); inter-rater concordance was .84, indicating a very good inter-rater agreement, according to indication[73].

Scoring was kept on specific score sheets, while watching the subjects' video-recorded experimental session. For each task, patients can obtain 0 or 1 point, on the basis of correct (1 point) or incorrect (0 point). In the comprehension task, the patient obtains 1 point if s/he correctly comprehended the proposed task, 0 point if s/he did not show comprehension of the task. The target item the patient had to understand was the communicative-pragmatic meaning of: an utterance in the linguistic scale, a gesture in the extralinguistic scale, a paralinguistic cue in the paralinguistic scale and the adequacy of the communicative act to social context/situation in the context scale. In

the production tasks, the patient obtained 1 mark if s/he has produced a congruent (with the requested task) communication act. In the linguistic scale the act produced must be an utterance, in the extralinguistic scale a gesture, in the paralinguistic scale a paralinguistic cues (i.e. producing an utterance with a specific intonation, for example a question, or showing a specific emotion). In the context scale the patient obtained 1 point if s/he produced a communication act appropriate to the context/situation and with respect to the formality or informality required. For all tasks the patients obtained 0 point if they were not able to produce the requested communication act in the requested modality (for a more detailed description of scoring criteria, see [5,56-59,74]). The psychometric properties of the ABaCo have been reported in[58]: scales showed satisfactory to excellent internal consistency, and the ABaCo showed excellent inter-rater agreement.

The neuropsychological and ToM tests (see Table 2) were also scored, following the relevant criteria available in the literature for each test.

Results

Communicative-Pragmatic assessment

We conducted a paired samples T-test analysis to verify the efficacy of the training program and analyze the trends in patients' performance on the equivalent forms of the ABaCo in the four phases of assessment.

Overall, we observed no improvements due to the non-specific control activities which the patients attended between T0 (baseline) and T1 (pre training), either in comprehension (t = .88; p = .41) or in production (t = .56; p = .59) (See Figure 2).

- Figure 2 about here -

Patients' performance at T2 (post training) was significantly better than at T1 (pre training) both on comprehension (T test: t = 4.9; p < .001) and on production tasks (t = 5.07; p < .001). The

improvements were stable even at three months after the end of the treatment, as shown by the comparison between the scores obtained at T2 (post training) and at the Follow Up assessment on comprehension (t = .18; p = .86) and production tasks (t = 1.03; p = .32) (see Figure 2).

In particular, significant improvements were detected on all the ABaCo scales (comprehension and production considered together), that is the Linguistic (t = 3.29; p = .005), Extralinguistic (t = 3.06; p = .008), Paralinguistic (t = 2.66 ; p = .02) and Context (t = 2.86; p = .01) scales. The improvements observed at the end of the treatment were also stable at three months after the end of treatment on all the scales, as shown by the comparison between scores obtained at T2 (post training) and at the Follow-Up assessment ($.21 < t < 1.44$; $0.17 < p < .84$) (see Figure 3).

- Figure 3 about here -

Cognitive and theory of mind assessment

At T1 and T2 we administered a series of neuropsychological tests, in order to obtain a precise cognitive profile of each patient before and after the training program; in particular we evaluated ToM and the most important cognitive functions related to communicative-pragmatic competence, i.e. attention, memory, planning ability, cognitive flexibility. We performed paired samples T-test analysis between scores obtained at each test at T1 (pre-training) and T2 (post training), to compare patients' performance before and after the training program.

The analysis did not reveal any statistically significant differences between performance pre and post training on Verbal Span tasks (T test: t = .70; p = .49), Spatial Span tasks (t = .34; p = .74), the Attentive Matrices test (t = .97; p = .35), the Trial Making test (t = .77; p = .45), the Tower of London test (t = 68 ; p = .50), Raven's Colored Progressive Matrices (t = 1.81; p = .09), the denomination scale of the Aachener Aphasic Test (t = 1.28; p = .22), the Sally and Ann task (t = .56; p = .58), or the Strange Stories task (t = .00; p = 1). It did, however, show a significant

improvement on the Immediate and Deferred Recall test for long-term verbal memory (t = 3.06; p = .01) and the Wisconsin Card Sorting Test (t = 3.66; p = .003). See Figure 4.

- Figure 4 about here -

Discussion

The aim of this study was to verify the efficacy of a new rehabilitation program, Cognitive-Pragmatic Treatment, in improving and enhancing communicative-pragmatic performance in a sample of patients with TBI. Poor communication abilities, often resulting from brain injury, may represent an obstacle for reintegration into daily activities[2]. The program's efficacy was measured by administering, before and after the training, the equivalent forms of the Assessment Battery for Communication[57], a tool able to provide a complete overview of the communication abilities of these patients, taking into account a wide range of pragmatic phenomena expressed through different communication modalities. To the best of our knowledge, this is the first study in the communicative-pragmatic domain to use the equivalent forms of the same tool in different assessment phases; thus, the possibility of the results being attributable to practice and memory is reduced.

All the patients were tested at the beginning of the research program in order: (i) to verify the presence of communication deficits, detected by comparing patients' performance with the normative value on the ABaCo[59] and (ii) to assess their baseline communication performance. The patients then attended various control rehabilitation activities not based on communication, which lasted the same number of hours as the CPT. These included socializing activities, such as group recreation and games, and intellectual and creative activities, such as reading the newspaper, cooking and painting.

After this period the patients were retested using the equivalent form B of the ABaCo and showed no improvement in their communication abilities. The patients subsequently attended the

CPT program twice a week for a total of 12 weeks, under the guidance of a psychologist. Nevertheless, speech therapists could also run the rehabilitation program, after being specifically trained on the structure and the procedures underlying the Cognitive Pragmatic Treatment.

The results of post-treatment tests revealed a significant improvement in patients' performance on comprehension and production tasks for all the scales of the ABaCo. In particular, we observed a significant improvement in linguistic aspects of communication, and in extralinguistic abilities, i.e. intentional use of hand gestures, and body movements to convey a meaning during communicative interaction. Moreover, at the end of the treatment program, the patients showed greater fluency and confidence in the use of tone of voice and gaze to communicate their emotions, as demonstrated by their scores on the paralinguistic scale of the ABaCo. Finally, the results revealed higher levels of social appropriateness, sensitivity to the context and social judgment, as measured on the context Scale of the ABaCo.

When considered overall, these preliminary results confirm previous findings[3, 42, 75,76] according to which chronic patients can also continue to learn and improve their abilities even years after the injury occurred. In particular our results are in line with studies reporting the efficacy of specific interventions in changing the psychosocial functioning and reorganization of everyday behaviors of these patients, focusing on social communication[75], social skills[42], self-regulation and self-awareness[77] and on cognitive components, related to communication abilities such as attentive processes[2] executive functions[78] and metacognitive strategies[79].

Moreover, our research indicated that the improvement at the communicative-pragmatic level remained stable in time: the effect of the treatment was maintained at 3 months follow-up.

In addition to the equivalent forms of the ABaCo, a neuropsychological and ToM test battery was administered to the patients before and after the rehabilitation program. No significant differences in the patients' cognitive profile were found, with the exception of a significant difference in performance pre and post treatment on the Wisconsin Card Sorting Test, and on the Immediate and Deferred Recall test for long-term verbal memory. We attribute the improvement in

cognitive flexibility to the patients' ability to generalize the strategies they experienced during the rehabilitation program, in particular referring to production activities, where participants were invited to plan and choose effective communication acts to suit a specific interaction context. For example, the participants watched a brief video in which a communication failure occurred and they were asked to assume the actor's perspective and to try to remediate (see Text, Supplemental Digital Content 2 where an example of the session's structure is provided). As a result of these activities and based on feedback received from the trainer and the other participants, several improvements were observed in terms of adaptation to different situations. The patients were encouraged throughout the whole of the training program to apply the strategies they experienced and were trained to use during the sessions to their everyday life. This process might also have influenced their cognitive flexibility in a wider perspective, with a consequent improvement in performance on the WCST. This interconnection between communicative performance and executive functions is in line with several studies in the literature. Some authors[27] suggest that the executive function system is necessary to engage in adaptive and effective communication and in particular the inability to integrate the utterances with the surrounding context might be attributable to a rigid and concrete information processing style. Moreover, impairments in executive functions, including concept shifting, may influence social communication, especially regarding topic shifts, inappropriate comments and literal interpretation of the statements (see[28]). Executive control therefore seems to be related to numerous aspects of personal functioning and daily-life[80] including those communicative abilities which are fostered during the course of our Cognitive Pragmatic Treatment.

As far as long-term verbal memory is concerned, the patients obtained higher scores at retest; in this case one possible explanation is that we included chronic patients at least one year after injury, with a high level of institutionalization, and since this test is frequently used in the neuropsychological assessment during the recovery process, it might have been difficult to control the learning effect of the test.

Often in everyday communication, the intended meaning simply does not correspond to the literal one: our training is primarily focused on the inferential chain necessary to fill the gap between the literal and the intended meaning: this is the case of indirect communication acts, deceitful and ironic statements, where the comprehension of the speaker's intended meaning (that does not simply correspond to the literally expressed one) is necessary, in order to achieve an effective communicative interaction. The activities during the treatment are designed to assist patients at this level and to encourage them to reflect on these inferential processes and to practice them with the help of the trainer. For example during the Cognitive Pragmatic Treatment the therapist focuses patients' attention on the fact that people who interpret what is said literally do not necessarily understand the other person's communicative intention, and that in order to fully comprehend what the actor intended to communicate they must make the effort to consider other possible communicative meanings, with respect to what the interlocutor actually (literally) says. From this perspective, our treatment differs from social skills trainings[3,71] as its aim is not to teach patients how to handle everyday life situations.

Furthermore in our rehabilitative training specific sessions are devoted to improve specific abilities, such as planning and theory of mind, since they are recognized [27] to play a role in sustaining communicative-pragmatic abilities.

Our preliminary findings appear to support the efficacy of the CPT program in improving and enhancing communicative-pragmatic abilities in patients with TBI, although further research is still necessary to generalize the results to the TBI population.

One limitation of the study is the lack of a control group. Given the heterogeneous clinical features of TBI patients, we used a within- rather than a between-subjects design. From T0 to T1 the patients attended cognitive and motor enhancing activities such as memory and attention groups, socializing and creative activities, which lasted the same number of hours as the training program. This did not result in any change in their communication profile as shown by their scores on the Equivalent form of the ABaCo administered at T1. Given this experimental design, the

clinical sample could itself operate as a control group, considering the different stages of the design, and the improvements in patients' pragmatic performance could be attributable to the CPT program rather than to any other non-specific activity. A second limitation of the present study is the small sample size: a larger number of participants would strengthen the results.

In conclusion, the Cognitive-Pragmatic Treatment program aims to address all aspects of communicative-pragmatic competence, by also taking into consideration abilities such as theory of mind and executive functions which contribute to the communicative performance of patients following brain injury[27, 28]. Our findings appear to support the efficacy of the CPT program in improving and enhancing communicative-pragmatic abilities in patients with TBI, although further research is still necessary to generalize the results to a larger number of patients suffering as a consequence of TBI.

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703 *Table 1 Clinical details of the participants (N = 15).*

	Sex	Age	Education (yrs)	Months post injury	GCS	MMSE
Participants ID						
01	M	37	8	67	6	28.42
02	M	35	10	102	3	29
03	F	22	8	12	3	25
04	M	50	8	42	4	30
05	F	35	10	45	7	25.75
06	F	40	16	78	3	24.59
07	F	42	8	100	3	25.62
08	M	32	8	50	3	23.42
09	F	44	8	72	5	18.62
10	M	45	10	228	5	28.62
11	M	30	11	58	-	27
12	M	23	8	18	4	28.59
13	M	35	8	54	4	28.42
14	M	51	5	24	-	27.26
15	M	30	13	192	8	21.75

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709 Table 2 *Neuropsychological and Theory of Mind tests.*
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Domain	Construct	Name of the Test	Description of the test
Attention	Selective attention, i.e. the ability to focus on a single or few elements of the perceptual field, for a certain amount of time.	Attentive Matrices[63]	The test consists of a series of patterns of numbers displayed on a sheet. The patient is required to check the numbers to find the target one. The tasks follow a trend of increasing complexity (from 1 to 3 digits to be found) and scores are attributed according to accuracy and completion time.
Attention	Divided attention, i.e. the ability to direct the attention on more than one cognitive task at the same time.	Trail Making test[64]	The test consists of two parts (A and B). Both parts of the TMT consist of 25 circles distributed over a sheet of paper. In Part A, the patient is asked to draw lines to connect the circles (1-25) in ascending order. In Part B, the circles include both numbers (1-13) and letters (A-L) and the patient is asked to connect the circles in an ascending pattern, alternating between numbers and letters (i.e., 1-A-2-B..). The patient is required to complete the tasks as quickly as possible. The direct score of each part is represented by the time required to complete the tasks. In addition to direct scores, the B-A difference score is used for clinical purposes as indicators of cognitive operations.
Memory	Verbal short-term memory, i.e. the ability to hold in mind a limitate amount of information (short words in the verbal modality), in an active, readily available state for a short period of time.	Verbal Span[63]	The patient is asked to repeat more and more complicated sequences right after the examiner. These sequences range between 1 and 9 words, each word is made up of two syllables. Scores are given according to the longest series for which two or more sequences are correctly repeated.
Memory	Spatial short-term memory, i.e. the ability to hold in mind a limitate amount of information (different locations and spatial relations between objects), in an active, readily available state for a short period of time.	Spatial Span[63]	In this test there are 9 wooden blocks arranged irregularly. The examiner taps the blocks in randomized sequences of increasing length, using from 2 to 10 blocks. Immediately after each tapped sequence, the subject is required to repeat the sequence. Scores are attributed according to the length of the sequence of at least two taps repeated correctly by the patient.
Memory	Verbal long-term memory, intended as the ability to extract and memorize information and recall them, immediately after their presentation and after a brief amount of time.	Immediate and Deferred Recall test for long-term verbal memory[63]	A standardized short story is read aloud by the examiner and the patient is asked for immediate free recall. After the first recall, the examiner reads the story again. Ten minutes later (non-verbal interfering activity) the patient is asked to recall the details of the story again (deferred recall). A separate score is attributed for each of the two recalls, based on precise coding criteria for each element of the story.

Domain	Construct	Name of the Test	Description of the test
Planning	Ability to create a mental representation of the current situation and of the goal and to be able to establish which actions are needed to transform the current state into the goal state. This ability requires a comprehensive plan of action, able to take into account constraints and alternatives.	Tower of London[65]	The test is a problem-solving task requiring the patient to rearrange three colored rings, from their initial position on three upright sticks to a new set of predetermined positions. Patients are required to achieve the goal arrangement in as few moves as possible and in accordance with very simple rules such as, for example, do not move more than one ring at a time.
Cognitive flexibility	Ability to switch between reasoning about different concepts, and to reason about multiple concepts at the same time.	Wisconsin Card Sorting Test – WCST[66]	The test is composed of a set of stimulus cards with shapes on them, which differ in color, number and form of the shapes. The patient is asked to complete a categorizing process, placing each response card below one of the stimulus cards. Rules for the correct completion of the task are given at the beginning and during the task. Scoring is mainly based on the number of categories completed and the number of errors.
Logical reasoning	Capacity to recognize patterns and relationships of theoretical or intangible ideas.	Coloured Progressive Matrices Raven[67]	This is a multiple-choice test consisting of a series of visual pattern matching and analogy problems pictured in colored non-representational designs. The patient is required to conceptualize spatial, design, and numerical relations of increasing difficulty. They are presented with a set of incomplete figures and the task is to complete the set choosing one of the six responses given below the figure.
Language	Ability to understand and to produce linguistic elements (i.e. words and short sentences) in a proper and precise manner.	Aachener Aphasie Test-denominatio n scale – AAT[68]	The AAT consists of five subtests and six spontaneous speech-rating scales. On the Denomination scale, the patient is required to say aloud the name of 40 visually-presented images of increasing complexity. The score is attributed on the basis of the accuracy of the answers.
Theory of Mind	Ability to infer thoughts and intentions of another person	Sally e Ann Task[69]	This task is administered through the use of two paper dolls (Sally & Ann) acting in a false belief scenario. The patient is required to correctly interpret the character behavior on the basis of the attributed beliefs to the characters themselves.
Theory of Mind	Ability to deal with doubly embedded representations. It requires understanding and reasoning about the fact that people have beliefs both about the world and about the contents of others' minds.	Strange Stories Task[70]	The task consists of a set of mentalistic stories (e.g. double bluff, mistakes, white lies..), read aloud by the examiner. The patient is asked to listen carefully and answer some questions requiring an inference about the characters' thoughts, feelings and intentions. Each story is scored separately and no time limit is given.

716 Table 3 *General structure of each rehabilitative session.*

Each session is organized as follows: *Introduction and summary of previous topics*: Introduction and explanation of the contents of the session, explicitly referring to daily life episodes in which the topic of the session plays an important role. This part of the program ends with a brief summary of what has been done in the previous sessions. *Comprehension activities*: Video-taped scenes, where 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). At the end of each video, the participants are invited to discuss the interactions depicted in the scenes, in order to stimulate and extend their comprehension of the proposed communicative situations. The discussion is also aimed at improving their discourse coherence. Moreover the trainer encourages the participants to interact with each other and to introduce compensatory communication strategies. *Production activities*: Role-playing activities - interactive scenarios reproducing everyday situations, in order to provide patients with specific communication strategies and feedback in a protected setting. Patients are invited to conduct in-group conversations, in order to stimulate their ability to use contextual elements, as proposed by the theory of referential communication. Specific sessions are devoted to enhancing various aspects of communication, such as the ability to recognize and correctly use facial expressions and prosody. *Conclusion and homework*: This gives patients the possibility to practice and to reinforce the aspects of communication addressed during the session.

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719 Table 4. *Schematic Structure of the Cognitive Pragmatic Treatment, reporting the topic and the*

720 *clinical tools of each session.*

Weeks	Sessions order	Topic	Tools and Procedures
1	1	Awareness	Construction of the clinical setting and introduction of the CPT
	2	General communicative ability	Video-taped scenes and role playing
2	3	General communicative ability	Video-taped scenes and role playing
	4	Linguistic ability	Video-taped scenes and role playing
3	5	Linguistic ability	Video-taped scenes and role playing
	6	Extra-linguistic ability	Video-taped scenes and role playing, based on the gestural modality
4	7	Extra-linguistic ability	Video-taped scenes and role playing based on the gestural modality
	8	Paralinguistic ability	Video-taped scenes, Facial expression recognition and tone of the voice tasks, role playing.
5	9	Paralinguistic ability	Video-taped scenes, Facial expression recognition and tone of the voice tasks, role playing.
	10	Paralinguistic ability	Video-taped scenes, Facial expression recognition and tone of the voice tasks, role playing.
6	11	Social appropriateness ability	Video-taped scenes and role playing
	12	Social appropriateness ability	Video-taped scenes and role playing
7	13	Conversational ability	Video-taped scenes, role playing and Tangram exercises
	14	Conversational ability	Video-taped scenes, role playing and Tangram exercises
8	15	Management of telephonic conversation	Audio-taped telephone conversations and role playing
	16	Management of telephonic conversation	Audio-taped telephone conversations and role playing
9	17	Planning ability	Sub-goal task activities, both alone and in groups (e.g. planning household chores)
	18	Planning ability	Sub-goal task activities, both alone and in groups (e.g. planning household chores)
10	19	Theory of Mind	Video-taped scenes and role playing
	20	Theory of Mind	Video-taped scenes and role playing
11	21	Narrative ability	Description tasks and speech elicitation pictures
	22	General communicative ability	Video-taped scenes and role playing
12	23	General communicative ability	Video-taped scenes and role playing
	24	Post-training awareness	Conclusions and feedbacks based on the video-recording of the sessions

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List of the Supplemental Digital Content

- Supplemental Digital Content 1. Structure of the rehabilitation sessions in the Cognitive-Pragmatic Treatment. doc

- Supplemental Digital Content 2. Example of a Session: Linguistic Abilities, Session 5. doc

Figure

Figure 1. Graphical representation of the experimental design

Figure 2. Comparison between the average scores obtained in the production and comprehension tasks, considered overall, at T0 – Baseline, T1 - pre, T2 - post training and Follow Up

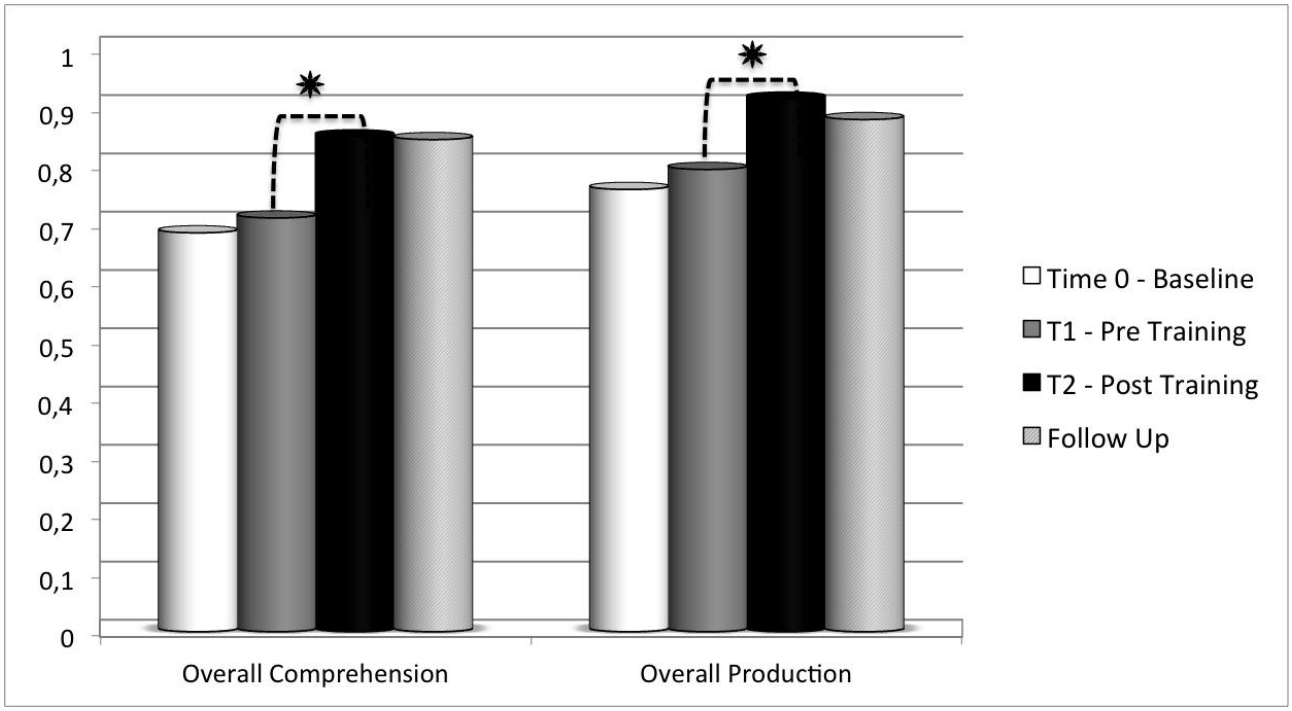

Figure 3. Comparison between the average scores obtained at the scales of ABaCo, at T1 - pre training, T2 - post training and Follow Up

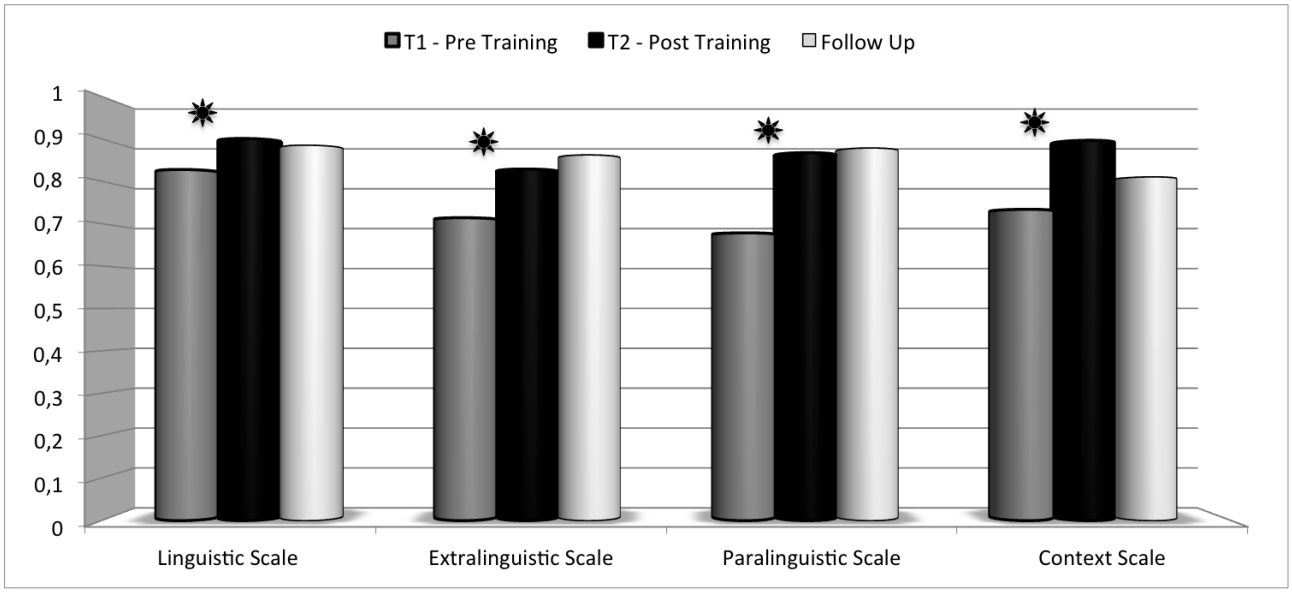

Figure 4. Mean scores obtained at neuropsychological and ToM tests at T1 - pre training and T2 - post training