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Minerva Psichiatrica 2016 ????;57(??):000-000

ORIGINAL ARTICLE

Pragmatic abilities in children and adolescents with autism spectrum disorder: a study with the ABaCo battery

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ABSTRACT

BACKGROUND: Pragmatic disorders are a core problem in individuals with autism spectrum disorder (ASD). Despite the clinical importance of detecting specific impairments, there are relatively few tools available to assess pragmatic abilities in these individuals. The present study aims to gain greater insight into the pragmatic skills of individuals with high-functioning ASD by using the Assessment Battery for Communication (ABaCo), a new clinical tool that assesses a wide range of communicative behaviors.
METHODS: The pragmatic performance of 16 individuals with ASD and 16 control participants were compared.
RESULTS: Participants with ASD had significantly poorer scores compared with healthy matched controls on all ABaCo scales, with the only exception of paralinguistic production.
CONCLUSIONS: ABaCo is an effective tool in identifying and assess pragmatic impairments in individuals in the Autism Spectrum Disorders.

(*Cite this article as:* Angeleri R, Gabbatore I, Bosco FM, Sacco K, Colle L. Pragmatic abilities in children and adolescents with autism spectrum disorder: a study with the ABaCo battery. Minerva Psichiatr 2016)

Key words: Autism spectrum disorder - Linguistics - Communication.

Communication is a core problem in autism spectrum disorders (ASD). Depending on the severity of disorders, communication problems may be characterized more strongly by linguistic deficits or difficulties in the pragmatic domain.[1] While individuals with more severe forms of ASD may be impaired in specific aspects of language-such as lexical and syntactic processing-, and may even exhibit absence of language, individuals with high-functioning ASD usually show more subtle difficulties related to pragmatics in both verbal and non-verbal communication (DSM-5[2]). Extant research suggests that the communicative impairment is particularly evident on tasks that require to infer the hidden intent behind the literal meaning of a message, and to take into account the specific social context in which communication occurs.[3]. From a clinical perspective, it is crucial to determine the extent as well as the nature of the communicative impairment associated with ASD, so that it may be possible to

improve the efficiency of both assessment and treatment.

The present paper aims to gain a better understanding of pragmatic functioning in individuals with high-functioning ASD, by using a new clinical tool for the assessment of the communicative abilities, the Assessment Battery for Communication (ABaCo).[4] ABaCo covers a wide range of communicative behaviors, and it has been already successful in assessing communicative impairment in other neuropsychological conditions.[5, 6]

The pragmatic domain refers to norms that regulate how language is used for communicative purpose in different contexts.[7] Pragmatics plays a critical role in daily communicative exchanges and social relationships; pragmatic abilities are crucial to convey effective meanings, and to provide expressive means for sharing thoughts, needs, and desires.[8] Despite individuals with high-functioning ASD usually maintain the ability to understand and produce linguistic messages, they may be unable to accurately convey and understand communicative intentions: they may have difficulties in reading between the line of communicative exchanges, understanding the speaker's intention whenever it does not correspond to the literal meaning of the expression. Since they are usually stuck to the literal interpretation of linguistic utterances,[9] understanding specific forms of communication can be challenging, as for example in the case of humor and indirect requests,[10] as well as sarcasm and figures of speech.[11] Moreover, individuals with ASD may have difficulties in identifying and maintaining the topic of a conversation, in making appropriate comments, and in conveying subtle shades of meaning during conversations; these disturbances are particularly evident in conversational discourse and narratives.[12, 13] The specific difficulties in the interpretation of others' communicative intentions may lead to a marked impairment in social exchanges, and many studies have highlighted the importance of assessing pragmatic skills, which usually represent the most debilitating symptoms of the ASD.[3]

The communicative impairment in individuals with ASD also extends to the extralinguistic domain, that is, the use of gestures for communicative purposes. The presence of deficits in extralinguistic communication in individuals with ASD has been widely reported in the clinical literature. Gestural impairment has been even established as a diagnostic measure in some clinical tools, such as the Autistic Diagnostic Observation Schedule (ADOS) [14] and the Autism Diagnostic Interview (ADI).[15]

Difficulties in extralinguistic communication may appear very early in childhood; children with ASD use fewer deictic (pointing) gestures than their typically developing (TD) peers, particularly when it comes to share experiences with their listeners.[16] Children with ASD also show less frequent, less varied, and less informative representational gestures (*i.e.*, gestures depicting semantic content through their form, placement, and/or motion).[17, 18] Young children with ASD have been found to display a reduced variety of iconic gestures [19] and to rarely use gestures spontaneously, even though they are able to producing gestures when it is explicitly required.[20] By adolescence, individuals with ASD produce representational gestures with frequency similar to that of TD peers, consistent with a larger trend of normalization of behavioral differences from childhood into adolescence in ASD.[21] However, there is also evidence that adolescents with HFA produce gestures which are more temporally asynchronous with speech.[22] Morett *et al.*[23] highlighted that improper use of gesture in ASD primarily reflects insufficient use of gesture to supplement meaning conveyed via speech. The cross-modal processing of speech and co-expressive gestures seems impaired in children and adolescents with high-functioning ASD, as revealed by their eyes movements in an eye-tracking study.[24]

Previous research has also highlighted the presence of impairments in the so-called "paralinguistic" aspect of communication. Paralinguistic communication includes many elements that accompany speech, such as tone, intonation, rhythm and prosody. Individuals with ASD may have problems interpreting the emotional states of their interlocutor; this emerged in a series of studies showing that they may ex-

perience difficulties in matching facial expressions of emotion with appropriate gestures, vocalizations, and postures; perceiving emotional expressions across different individuals;[25] labeling facial expressions of emotion;[26] matching basic emotions and neutral expressions;[27] and decoding emotions through facial expressions, prosody, and verbal content.[28] Although emotion recognition from facial expression in ASD has been the focus of a large number of studies, the results have been mixed. Some empirical studies have shown that adults with ASD fail to appropriately react to some forms of negative emotions,[29] while other studies have failed to detect this deficit in emotion recognition,[30] or have shown that the impairment is restricted to complex emotions.[31] Individuals with ASD are also characterized by specific impairments in the production of paralinguistic aspects of communication; speech production abnormalities primarily relate to prosodic errors and rhythmic features of speech, such as stress and intonation.[3]

Individuals with ASD show marked social deficits, which are often connected to their communicative impairment. They often report social isolation and unfulfilled social relationships, sometimes expressing the desire to receive specific information on how to engage in social conversations, recognize communicative behaviors that others might consider inappropriate, and identify appropriate topics to discuss.[32] They may also fail to use a shared referential frame or shared knowledge in their communicative interactions, as revealed by their difficulty in starting a conversation and providing the listener with appropriate background information. They are unlikely to take the listener's perspective into account, and show low sensitivity to faux pas and to conversational norms, such as appropriately taking and giving turns.[33] The idea that the speakers implicitly follow some rules to cooperate towards an accepted purpose during conversations was advanced by Grice *et al.*,[34] and some studies using this framework have shown that individuals with ASD have problems in understanding how much information they should include in their utterances.[13]

Despite the importance of evaluating pragmatic deficits, there are only a few clinical tools specifically developed for the assessment of pragmatic skills in ASD. Available clinical tools that focus on pragmatic language include the Pragmatic Language Skills Inventory (PLSI),[35] and the Children's Communication Checklist (CCC-2),[36] which are checklists designed to evaluate children's communicative performance in natural settings. Even though checklists are informative, more standardized measures of pragmatic abilities would be important to provide a clear picture of pragmatic weaknesses and strengths in ASD. One of these measures is the Test of Pragmatic Language (TOPL-2),[37] in which children are shown some pictures depicting common social situations and required to generate responses assuming the perspective of a character. While this is an important step forward, the TOPL focuses mostly on the production side of communicative exchanges. Similarly, Lam *et al.*[38] attempted to derive a profile of pragmatic ability in children with HFA using the Pragmatic Rating Scale.[3] This tool is an observational scale that categorizes 19 pragmatic anomalies (such as insufficient background information, abrupt topic change, topic preoccupation, inappropriate topics, awkward expressions, too much detail) occurring during face to face interaction. Children with HFA showed significantly more pragmatic impairments than a TD control group in all the categories.

There are a number of reasons why none of these tools provide a comprehensive assessment of communication. First, these tools focus exclusively either on production or on comprehension of communicative acts; second, they have a narrow focus on a limited set of pragmatic phenomena; and finally, they do not assess communication across different communicative modalities (linguistic, extralinguistic, and paralinguistic).

Assessing all the components of communication seems particularly relevant when examining children and adolescents with ASD, given the crucial role of communicative skills in both the diagnosis of ASD and the likely prog-

nosis. Indeed, follow-up studies have shown that language and communication problems may be persistent, and closely related to subsequent prognosis in ASD.[39]

In the present study we aimed to gain more insight in the pragmatic abilities of children and adolescents with ASD using a new clinical tool, the ABaCo.[40-42] The ABaCo was designed to assess both comprehension and production of a wide range of communicative behaviors in different communicative modalities-linguistic, extralinguistic, and paralinguistic-, and social situations. ABaCo has been successfully administered in a number of previous studies for assessing pragmatic abilities in patients affected by traumatic brain injury,[5, 43] aphasia,[44] right hemisphere damage [45] and schizophrenia.[6] The ABaCo can also be applied to obtain a comprehensive overview of patients' communicative weakness and strengths in order to guide individualized rehabilitation treatments.[46, 47] Moreover, it has been shown to have good construct validity, high inter-rater agreement, and good internal consistency.[4, 48]

The main goal of the present study was to examine the pragmatic abilities of children and adolescents with ASD with a clinical tool that would provide a broad, accurate, and reliable assessment. The assessment of pragmatic aspects of communication is a crucial feature in planning rehabilitative goals and interventions for children and adolescents with ASD.

Materials and methods

Participants

Sixteen children and adolescents with high-functioning ASD (4 female, 12 male; chronological age range: 4.9-15.2 years; M=9.46; SD=2.55; mental age: M=8.7; SD=2.94) were recruited as participants. The control group comprised 16 typically developing children and adolescents (4 female, 12 male; chronological age range: 4.8-15.1 years; M=8.73; SD=2.96; mental age: M=8.94; SD=3.05), matched to clinical participants for sex and mental age. A *t*-test comparison showed no significant group differences for mental age, $t(30)=1.85$, P=0.09. A summary of participants' demographics for both groups is reported in Table I. The diagnosis of each high-functioning ASD participant was made independently of the research by expert clinicians; diagnoses were confirmed according to DSM-5 diagnostic criteria. All the participants were Italian native-speakers and they didn't suffer from co-morbid mental illnesses or substance abuse. Participants with ASD were recruited from local residential mental health care centers in Piedmont and Lombardy regions (Italy). Parents gave informed consent for their children participation. Approval from the Bioethical committee of the University of Turin was obtained for this study.

Material

In the present study, we used four scales of the ABaCo.[40-42] The assessment scales of the ABaCo used in the present study were the following: 1) linguistic; 2) extralinguistic; 3) paralinguistic; and 4) context scale.

Linguistic and extralinguistic scale

The linguistic scale of the ABaCo investigates the comprehension and production of communicative acts expressed through linguistic means; similarly, the extralinguistic scale assesses the comprehension and production of communicative acts, but in this case expressed only through gestures. The linguistic and extralinguistic modality share the same under-

Table I.—*Summary of participants characteristics.*

Group	Sex		Chronological age		Mental age		IQ	
	M	F	M	SD	M	SD	M	SD
ASD	12	4	9.46	2.55	8.7	2.94	90.94	15.48
Control	12	4	8.73	2.96	8.94	3.05	101.12	9.16

lying communicative abilities and require the same inferential processing;[49] for this reason, the linguistic and the extralinguistic scales of ABaCo include the same type and the same number of pragmatic tasks (Table II).

Paralinguistic scale

The paralinguistic scale of the ABaCo investigates the comprehension and production of those aspects that generally accompany a communicative act, such as proxemics and prosody.

Context scale

The context scale investigates the adequacy/inadequacy of a communicative act with respect to Grice's Maxims and to the social norms that regulate communicative interaction.

Each evaluation scale of the ABaCo comprises both comprehension and production tasks (Table II).

The total number of tasks was 164 consisting in 100 videotaped scenes depicting everyday communicative interactions, while the remaining 64 tasks consisted in *vis-à-vis* in-

Table II.—*Description of the comprehension and production tasks composing each scale of ABaCo.*

Linguistic and extralinguistic scale	
Comprehension tasks	*Standard* (*i.e.* direct and indirect communicative acts) and *Non-Standard Communicative Acts* (*i.e.* deceits and ironies). Presentation of short videos where two characters are engaged in a communicative interaction (verbally in the linguistic scale and only through gestures in the extralinguistic scale). The patient is required to understand the communicative act produced by the actors.
Production tasks	*Standard* (*i.e.* direct and indirect communicative acts) and *Non-Standard Communicative Acts* (*i.e.* deceits and ironies). Presentation of short videos where two characters are engaged in a communicative interaction (verbally in the linguistic scale and only through gestures in the extralinguistic scale). Participants are requested to answer the actor assuming his partner's perspective, that is, to produce a communicative act. In the linguistic tasks, participants are asked to produce a communicative act verbally, while in the extralinguistic tasks participants were asked to reply using only gestures.
Paralinguistic scale.	
Comprehension tasks	*Basic Communication Acts* (assertions, questions, requests, and commands): the examiner shows the participants short videos where an actor, speaking an invented language, makes an assertion, asks a question, makes a request or gives a command. Participants are asked to understand the type of communicative act proffered, focusing on paralinguistic indicators. *Basic Emotions* (e.g. anger, fear, happiness, and sadness): the examiner shows the participants short videos where an actor, speaking also in this case an invented language, expresses an emotion. Participants have to recognize this emotion, focusing on paralinguistic indicators. *Paralinguistic Contradiction*: The examiner shows participants short videos where two characters are engaged in a communicative interaction: one of the actors verbally expresses something that is in contrast with the paralinguistic indicators (*i.e.*, the actor says "I like that very much!" while his voice and attitude reveal that he doesn't like it at all). Participants have to grasp the inconsistency between the expressed content and the paralinguistic indicators.
Production tasks	*Basic Communicative Acts* (assertion, questions, requests, and commands): the examiner asks the participants to produce assertions, questions, requests, and commands, paying special attention to the paralinguistic indicators. For example, the examiner tells the participants "Ask me whether it is sunny today" or "Tell me that it is sunny today". *Basic Emotions*: the examiner asks the participants to produce communicative acts colored by a specific emotion or mood; the examiner provides the semantic content of the requested act and the emotion with which it had to be expressed. For example, the examiner asks: "Tell me that you received a letter. Tell me that in a happy way".
Context scale.	
Comprehension tasks	*Discourse Norms* (based on *Grice's Maxims*): the examiner shows the participants short videos where two agents are engaged in a communicative interaction; the actors communicate either according to or violating the norms of discourse (*i.e.* giving a generic, false, irrelevant or ambiguous answer). Participants are asked to detect and explain the observed adequacy/inadequacy. (e.g.: "Where are you going precisely?" "I'm going out"; in this case, less information than those needed where provided, thus violating the maxim of quantity). *Social Norms*: the examiner shows the participants short videos where two agents are engaged in a communicative interaction; the actors communicate either according to or violating the norms of social appropriateness or in a not appropriate manner with respect to the given social context. (e.g. "Could you lend me your pen?" "I don't want to be disturbed!", that would be considered an impolite reply to most speakers.
Production tasks	*Social norms*. The examiner provides a semantic content and asks the participants to produce communicative acts requiring different levels of formality. E.g., "Imagine you have to apologize for a delay to your lawyer… What do you say? […] Now, imagine that you have to apologize for a delay with one of your friends. What do you say?".

teractions with the examiner. Each videotaped scene lasted 20-25 seconds, and included a controlled number of words (range: 7±2).

Scoring procedure

The participants' answers were coded offline from video records. For each task it was possible to obtain a score of 0 or 1, depending on whether the answer was correct (score=1) or incorrect (score=0). Two raters coded independently all items of the Battery. These raters were also unaware of the experimental design and diagnoses at the time of rating. For a more detailed explanation of the scoring procedure, see Sacco K *et al.*[4, 48]

Procedure

Participants with ASD were assessed individually in a quiet room at their medical rehabilitation center, while the TD participants were tested at their school. Children were video-recorded during the experimental sessions to allow off-line scoring procedure. The tasks were presented in two different randomizations; each of the randomizations included the same number and the same type of items. Each child was randomly assigned to one of the two orders of presentation.

Results

Linguistic and extralinguistic scale

Means of correct responses for both linguistic and extralinguistic scales are displayed in Table III, reporting both ASD and control participants' scores. The ASD group performed worse than control group in all of the evaluation scales of ABaCo, with the exception of the paralinguistic production. In more detail, the group difference was significant at the specified 0.05 level in the linguistic scale, in both comprehension, $t(30)=5.13$, $P<0.0001$, $d=0.25$, 95% CI [0.36, 0.15], and production tasks, $t(30)=5.01$, $P<0.0001$, $d=0.3$, 95% CI (0.43, 0.18), in the extralinguistic scale, in both comprehension, $t(30)=4.39$, $P<0.0001$, $d=0.22$, 95% CI (0.32, 0.12), and production tasks, $t(30)=7.95$, $P<0.0001$, $d=0.47$, 95% CI (0.59, 0.35), in the paralinguistic comprehension scale, $t(30)=2.62$, $P<0.014$, $d=0.16$, 95% CI (0.29, 0.04), and finally in the context scale, in both comprehension, $t(30)=5.28$, $P<0.0001$, $d=0.45$, 95% CI (0.63, 0.28), and production tasks, $t(29)=4.47$, $P<0.0001$, $d=0.45$, 95% CI (0.66, 0.24). In the paralinguistic production scale, the difference between ASD participants and controls was not significant at statistical level, $t(30)=1.47$, $P=0.153$, $d=0.11$.

Comprehension of standard, deceitful, and ironic communicative acts

We conducted Analysis of Variance (ANOVA) analysis in order to investigate the difference between the two participant groups in the comprehension of the different pragmatic phenomena. To investigate participants' performance in the comprehension of standard, deceitful and ironic communicative acts, data were entered into ANOVA with one between-

TABLE III.—*Summary of means (standard deviations in parentheses) for scores on the linguistic and extralinguistic tasks.*

	Comprehension				Production			
	ASD		Controls		ASD		Controls	
	M	SD	M	SD	M	SD	M	SD
Linguistic Tasks								
Standard	0.53	(0.46)	0.78	(0.36)	0.84	(0.22)	10.00	(0.00)
Deceit	0.50	(0.41)	0.92	(0.18)	0.34	(0.37)	0.87	(0.22)
Irony	0.12	(0.22)	0.25	(0.37)	0.11	(0.2)	0.41	(0.26)
Extralinguistic Tasks								
Standard	0.70	(0.36)	0.76	(0.3)	0.69	(0.27)	100	(0.00)
Deceit	0.32	(0.39)	0.69	(0.32)	0.07	(0.21)	0.78	(0.27)
Irony	0.09	(0.2)	0.19	(0.32)	0.06	(0.1)	0.66	(0.41)

subjects factor (type of participant, with two levels, corresponding to ASD and control participants) and one within-subjects factor (type of phenomenon, with three levels: standard, i.e. direct and indirect communicative acts, deceit and irony), for both the linguistic and extralinguistic scales. In the linguistic scale, the ANOVA analysis revealed a main effect of the participant group ($F_{(1, 30)}$=26.14; P<0.0001; η^2=0.47). There was a main effect of the type of pragmatic phenomenon ($F_{(2, 60)=}$35.76, P<0.0001, η^2=0.54). The linear contrast revealed a linear decrease on scores depending on the type of pragmatic phenomenon ($F_{(1, 30)}$=56.8, P<0.0001, η^2=0.65): standard communicative acts were the easiest task, followed by deceits and finally by ironies, the most difficult ones.

Also for the extralinguistic scale, data were entered into ANOVA analysis with type of participant as between-subjects factor, and we found a main effect of group ($F_{(1, 30)}$=17.44, P<0.0001, η^2=0.37): ASD participants performed worse than controls in all the tasks.

There was also a main effect of the type of pragmatic phenomenon ($F_{(2, 60)}$=57.26, P<0.0001, η^2=0.66). The linear contrast revealed a linear decrease on scores depending on the type of pragmatic phenomena ($F_{(1, 30)}$=135.76, P<0.0001, η^2=0.82): standard communicative acts were the easiest task, followed by deceits and ironies, also in this case the most difficult ones.

Production of standard, deceitful and ironic communicative acts

To investigate children's performance in production of standard, deceitful and ironic communicative acts, data were entered into ANOVA with one between-subjects factor (type of participant, with two levels, corresponding to ASD and control participants) and one within-subjects factor (type of phenomenon, with three levels: standard, deceit and irony), for both the linguistic and extralinguistic scales. In the linguistic scale, ANOVA analysis revealed a trend for a difference between groups ($F_{(1, 30)}$=27.85, P<0.0001, η^2=0.48). The same result emerged in the extralinguistic scale ($F_{(1, 28)}$=81.22, P<0.0001, η^2=0.74).

ANOVA analysis revealed also a trend for a difference among the type of pragmatic phenomenon, both in the linguistic scale ($F_{(2, 60)}$=91.29, P<0.0001, η^2=0.75), and extralinguistic scale, ($F_{(2, 56)}$=49.84, P<0.0001, η^2=0.64). In more detail, a linear contrast showed the following trend of difficulty in linguistic production: standard communicative acts were the easiest to produce, followed by deceits and finally by ironies, the most difficult ones ($F_{(1, 30)}$=220.68, P<0.0001, η^2=0.88). In the extralinguistic scale, the linear contrast reveals the same trend of difficulty ($F_{(1, 28)}$=66.99, P<0.0001, η^2=0.71).

Paralinguistic scale

Overall participants' performance on the paralinguistic scale is displayed in Table IV.

To investigate participants' performance in the comprehension of paralinguistic aspects, data were entered into ANOVA with one between-subjects factor (type of participant, with two levels, corresponding to ASD and control groups) and one within-subjects factor (type of element, with three levels: basic communicative act, basic emotion and paralinguistic contradiction). ANOVA analysis revealed a trend for a difference between groups ($F_{(1, 30)}$=5.38,

TABLE IV.—*Summary of means (standard deviations in parentheses) for scores on the paralinguistic tasks.*

	Comprehension				Production			
	ASD		Controls		ASD		Controls	
	M	SD	M	SD	M	SD	M	SD
Basic emotions	0.75	(0.15)	0.90	(0.1)	0.72	(0.34)	0.82	(0.22)
Basic communicative acts	0.47	(0.24)	0.54	(0.25)	0.71	(0.27)	0.88	(0.13)
Paralinguistic contradiction	0.35	(0.39)	0.65	(0.37)	--	--	--	--

p=0.027, η^2=0.15). The ANOVA analysis revealed a main effect of type of element ($F_{(2, 60)}$=23.94, P<0.0001, η^2=0.44): basic emotions were the easiest task, followed by basic communicative acts and finally by paralinguistic contradiction, the most difficult ones.

To investigate performance in the production of paralinguistic elements, we conducted ANOVA with one between-subjects factor (type of participant) and one within-subjects factor (type of element, with two levels: basic communicative acts and basic emotion). The analysis revealed that there was no significant differences between groups ($F_{(1, 29)=}$2.44, P=0.129). The analysis revealed no effect of type of element ($F_{(1, 29)=0.}$17, P=0.68).

Context scale

Table V summarizes overall means of correct responses on context scale, for both comprehension and production tasks. To investigate participants' performance in comprehension on the context scale, we conducted ANOVA with one between-subjects factor (type of participant, with two levels corresponding to ASD and control groups) and one within-subjects factor (type of violation, with two levels: social norm and Grice's Maxim). There was a main effect of the type of violation ($F_{(1, 30)}$=9.57, p=0.004, η^2=0.24): the comprehension of the violation of social norms was easier than the sensitivity to the violation of Grice's Maxims. The between-subjects analysis revealed a significant differences between groups ($F_{(1, 30)}$=31.85, P<0.0001, η^2=0.85).

To investigate production performances on the context scale, we conducted ANOVA with one between-subjects factor (type of participant) and one within-subjects factor (type of context, with two levels: informal and formal). The analysis revealed a main effect of the type of context ($F_{(1, 29)}$=7.88, P=0.009, η^2=0.21): formal communicative acts were more difficult to produce than informal ones. The difference between groups was also significant ($F_{(1, 29)}$=16.09, P<0.0001, η^2=0. 36).

Discussion

The aim of the present study was to provide insight into the nature of pragmatic abilities in children and adolescents with high-functioning ASD. The ABaCo was chosen because of its clinical sensitivity to subtle pragmatic deficits in other neuropsychological disorders.[5, 6, 43] This study gave us the opportunity to evaluate its efficacy in the assessment of communicative abilities in the context of ASD. In line with the current clinical description, the ABaCo showed to be sensitive to pragmatic deficit in individuals with ASD, which performed significantly worse than the control group in all the pragmatic areas evaluated by the ABaCo. The difficulties extended to the linguistic and the extralinguistic domains, as well as to the paralinguistic and the social aspects of communication. The results are in line with the clinical description of ASD that identifies the difficulties in communicative exchanges as most pervasive and the core problem of the disorders (DSM-5).[2]

Concerning linguistic communication, individuals with ASD performed significantly worse than matched TD participants in both comprehension and production tasks. A trend of difficulty emerged in the comprehension and production of standard communicative acts, deceit, and irony, starting from the simplest to the most complex ones. As argued in previous

TABLE V.—*Summary of means (standard deviations in parentheses) for scores on the context tasks.*

	Comprehension				Production			
	ASD		Controls		ASD		Controls	
	M	SD	M	SD	M	SD	M	SD
Social Context	0.35	(0.36)	0.91	(0.13)	--	--	--	--
Grice Maxims	0.29	(0.26)	0.68	(0.28)	--	--	--	--
Informal	--	--	--	--	0.83	(0.29)	0.98	(0.06)
Formal	--	--	--	--	0.55	(0.4)	1.00	(0.00)

studies,[5, 50] this trend can be explained by differences in the mental representations involved and inferential load. The same trend also emerged in the extralinguistic communication-both in comprehension and production tasks-further supporting the theoretical assumption that linguistic and extralinguistic modalities are different means of expression of the same underlying communicative competence.[49].

Individuals with ASD also showed difficulties in understanding the paralinguistic aspects of communication, as when recognizing and interpreting the emotional cues that accompanying speech. In more detail, ASD participants showed more difficulties compared to controls in perceiving paralinguistic contradiction, a very common occurrence in everyday communication characterized by a mismatch between the semantic context expressed in speech and the accompanying paralinguistic cues (*i.e.*, prosody and facial expression). They also performed worse than controls in detecting paralinguistic elements accompanying both basic communication acts (*i.e.*, assertion, question, request, and command) and basic emotions (*i.e.*, anger, fear, happiness, and sadness). ASD participants also obtained lower scores than TD participants in the production tasks of the paralinguistic scale, but the difference was not statistically significant. Even though the difference does not reach significance, the trend is in line with other empirical results.[3] Studies focused on emotion understanding have shown that individuals with high functioning ASD are usually able to identify simple mental states, such as basic emotions or intentions.[51] However, when these simple mental states were presented in a more complex and interpersonal experimental setting, the ability of individuals with high functioning ASD to understand and produce the same basic mental states appeared to be very compromised. This is exactly what happened in our study, where basic communicative acts were framed in everyday communicative situations.

Finally, individuals with ASD differed from TD controls in both comprehension and production of appropriate communicative acts in relation to the social context. Social communication difficulties characterize individuals with ASD even in adulthood.[52] Accordingly, in the comprehension tasks of the context scale of ABaCo, they showed difficulties in detecting violations of conversational norms (*i.e.*, Grice's maxims), as well as in the understanding of the violation of the social norms related to different communicative contexts. A similar difficulty in dealing with social norms also emerged in the production tasks. In line with previous results, individuals with ASD were not able to modify their communicative acts according to the social context.[32]

Conclusions

To conclude, the administration of the ABaCo revealed that individuals with ASD showed a wide range of pragmatic disorders, and that the tool seemed to be useful for gathering an accurate picture of communicative impairments in these individuals, providing a cohesive view of their impairment. ABaCo was able to evaluate different communicative modalities and different pragmatic phenomena typically impaired in ASD. The possibility to assess many aspects of communicative abilities at once seems to be particularly useful in the case of ASD for different reasons. ABaCo allows to compare directly different communicative skills and to have a comprehensive profile of communicative functioning. Given the heterogeneity of the clinical manifestations in the autism spectrum disorder, a comprehensive evaluation of different components of communicative abilities might help clarify the specificity of the pragmatic disorder relative to other cognitive and social aspects. Further investigation with a larger sample of ASD might contribute to shed light on this point.

Finally, the current study might have implications for clinicians in designing specific rehabilitative interventions on communicative skills for children and adolescent in the ASD. A precise assessment and a thorough understanding of the communicative disorders shown by each individual with ASD can form the basis of individualized rehabilitation programs.

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Conflicts of interest.—The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

Manuscript accepted: March 11, 2016. - Manuscript received: February 22, 2016.