Metaphors and jokes in patients with Amyotrophic Lateral Sclerosis: The relationship between pragmatics and Theory of Mind

Luca Bischetti[1], Chiara Bonomi[2], Giorgio Arcara[3], Serena Lecce[2], Mauro Ceroni[2] and Valentina Bambini[1] – [1] University School of Advanced Study (IUSS) Pavia; [2] University of Pavia; [3] IRCCS, Fondazione Ospedale San Camillo

Introduction. Amyotrophic Lateral Sclerosis (ALS) has been long described as a disease restricted to the motor system. However, recent findings suggested that ALS affects also cognition [1], social cognition [2], as well as pragmatics [3;4]. A relevant issue thus becomes how impairments in these domains mutually influence each other, with potential implications also for the theoretical debate on the relationship between pragmatics and Theory of Mind (ToM) [5;6]. In this study, we looked at the interplay between pragmatics and ToM in ALS by using two new tasks testing the comprehension of two types of metaphors (physical vs. mental) and two types of jokes (phonological vs. mental). We hypothesized a specific relationship between pragmatics and ToM, depending on the mental characteristics in tasks' stimuli.

Methods. We recruited 30 non-demented patients with ALS (diagnosed according to [7;8]; 15F; age *M*=67.63, *SD*=5.99; education *M*=9.43, *SD*=3.05; disease duration *M*=45.37 months, *SD* = 33.26; 24 with spinal onset and 6 with bulbar onset) and a sample of 29 age- and education-matched controls (11F, age *M*=65.69, *SD*=5.37; education *M*=10.86, *SD*=3.49). All subjects were assessed for global cognitive skills (ECAS) [9], ToM (Faux Pas) [10], pragmatic abilities (APACS) [11], grammar [12], and vocabulary [13]. Moreover, all subjects were administered the Physical and Mental Metaphors (PMM) tasks and the Phonological and Mental Jokes (PMJ) task.

PMM task: The test consisted of 14 novel metaphors in the nominal form, balanced for a number of psycholinguistic features (e.g., frequency), expressing either physical characteristics (*That boxer is a panda*) or psychological characteristics (*Adolescents are pendulum-clocks*). Subjects were required to explain the meaning of the expressions. Responses were scored for accuracy (0-1-2 for incorrect, partial, and correct answers).

PMJ task: The test consisted of 14 jokes, each presented as a story with three possible endings: one funny (underlined in the examples below), one straightforward, and one unrelated. In phonological jokes, the incongruity originated from a sound similarity between the punning and the expected non-humorous word: *Two university professors: "Dear colleague, starting tomorrow I'll leave my duties for a year and I'll move to Brazil." And the other says: "Oh, I see, you take a <u>sambatical</u>/sabbatical/leap year to rest a bit"*. In mental jokes, the incongruity originated from the attribution of a false belief to one character: *Two female friends talk about their youth while they are having tea. One says: "You know, my love story ended in a tragedy." And continues: "Yes, eventually I <u>married</u>/left/combed him".* Subjects were asked to choose which ending worked best as a punchline for the joke. Responses were scored for accuracy (0-1 for incorrect and correct).

Data were analyzed with Linear Mixed Effects Models. For each task (PMM and PMJ) two models were run. The first investigated task performance in the two groups and the role of ToM, and included accuracy as dependent variable, two categorical variables (Group and Type of stimulus, i.e., physical vs. mental for PMM and phonological vs. mental for PMJ), one continuous variable (ToM scores) as predictors, and subjects as random factor. The second model was restricted to patients and aimed at selecting (with a backward elimination procedure) the best predictors of task accuracy, taking into account clinical variables and the tests included in the assessment (cognition, ToM, pragmatics, grammar, vocabulary).

Results. In the PMM task, the first model showed a significant interaction between Group and Type of stimulus ($p<.001$): patients performed worse than controls in mental metaphors ($p<.001$), but not in physical metaphors ($p=.815$). Moreover, results showed a significant interaction between Type of stimulus and ToM ($p=.016$). Post-hoc test showed that the slope

of the ToM covariate was steeper for physical metaphors than for mental metaphors (p=.047). Since this result was puzzling, we further explored the Type of stimulus X ToM interaction in each group. In patients, we observed a steeper slope of the ToM covariate for physical metaphors compared with mental metaphors (p=.032). In controls, the difference between slopes was not significant (p=.456). The second model showed three significant predictors of PMM accuracy, i.e., pragmatics (p<.001), type of metaphor (p<.001), and grammar (p=.015). In the PMJ task, results on accuracy scores showed a significant effect of Group (p=.039), with controls outperforming patients, and of Type of stimulus (p=.015), with mental jokes being more difficult than phonological ones. Moreover, results showed a significant ToM effect on jokes in general (p=.026). The second model showed two significant predictors of PMM accuracy, i.e., cognition (p<.001) and type of joke (p=.028).

Discussion. Concerning metaphors, patients' difficulties seem restricted to metaphors requiring inferences on mental, rather than physical, characteristics. Interestingly, and unexpectedly, ToM skills seems to play a role only for physical and not for mental metaphors, which is in contrast with findings reported for children [9]. We believe that this result is to be interpreted in light of the severe ToM impairment in ALS patients: given their mentalistic load, mental metaphors were difficult in general, independently on individual ToM skills, while ToM skills could still be beneficial to infer the meaning of the easiest type of metaphors, i.e., the physical ones. Concerning jokes, patients' difficulties were diffused and affected both phonological and mental humor. Moreover, ToM played a role in both types of jokes. In short, for metaphors we observed a ToM involvement that depends on the type of metaphor, while for jokes the relationship with ToM is widespread. The models determining the contribution of the different predictors further highlighted the differences between metaphors and jokes, indicating that the ability to understand metaphors is tied to more general pragmatic and linguistic skills, whereas the ability to understand jokes seems to be related to the global cognitive profile. This study contributes to describe the complex phenotype of ALS, highlighting the interplay of communicative and cognitive deficits. Besides this important clinical side, this study also sheds light on the theory-relevant issue of the relationship between pragmatics and ToM [5;6]. Our findings speak in favor of the idea that these abilities do not completely overlap. Specifically, our study suggests that ToM involvement depends on the pragmatic tasks (being for instance more pervasive in humor than in metaphor) and also on the level of impairment of the specific clinical population.

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