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A Multimodal corpus to check on pragmatic competence for Mild Cognitive Impaired aging people.

Approche sur corpus des compétences pragmatiques et multimodales des personnes âgées présentant un trouble cognitif léger.

Abstract

This article presents a multimodal video corpus with the principal aim to model and predict the effects of aging in Mild Cognitive Impairment situation on pragmatic and communicative skills. We take as observable variables the verbal pragmatic markers and non-verbal pragmatic markers. This approach, at the interface of the psycholinguistics, cognitive sciences and rehabilitation medicine (speech-language pathology and therapy) is part of a longitudinal research process in an ecological situation (interviews conducted by close intimate of the elderly). In the first part of the article we present the linguistic, cognitive and social characteristics of aging in its continuum up to mild cognitive impairment and pathological disorders such as Alzheimer's disease. In the second part, we develop a multimodal approach, in particular to inform and enrich speech and language therapy knowledge. Finally, we present our experimental design and preliminary results on two female participants over 75 years of age with mild cognitive impairment. Our general findings indicate that with aging, verbal pragmatic markers acquire an interactive function that allows people with Mild Cognitive Impairment to maintain intersubjective relationships with their interlocutor. In addition, at the non-verbal level, gestural manifestations are increasingly mobilized over time with a preference for non-verbal pragmatic markers with a referential function and an interactive function. One such non-verbal manifestation compensates for naming deficits, planning difficulties, discursive hitches; while another optimizes and maintains the interaction with the interlocutor.

Clinicians have a duty to develop their professional practice through an evidence-based clinical approach whose main objective is to reconcile clinical practice with the best evidence from research [Dollaghan, 2007]. In the case of speech-language pathology, clinicians consider themselves very limited in this approach [Lof, 2011; McCurtin, 2011], especially for patients with mild cognitive impairment [Mungas *et al.*, 2010; Hopper, 2013; Morello, 2017] and more specifically when it comes to assessing or supporting language functions [Cummings, 2014]. The studies focusing on Mild Cognitive impairment require longitudinal corpora i) to understand the naturally occurring evolutions in subjects, ii) the implication of the cognitive reserve in each individual, and iii) to take advantage of these parameters as evidence for research and earlier rehabilitation. We aim to show the benefits of linguistic and interactional scientific investigation methods through fragile aging, for health professionals and everyday caregivers.

Résumé

Cet article présente un corpus vidéo d'analyse multimodale dont l'objectif principal est de modéliser et prédire les effets du vieillissement en situation de trouble cognitive léger sur les compétences pragmatiques et communicationnelles. Nous prenons comme observable les marqueurs pragmatiques verbaux et non-verbaux. Cette démarche, à l'interface des sciences du langage, des sciences cognitives et de la médecine réadaptative (l'orthophonie) s'inscrit dans un processus de recherche longitudinale en situation écologique (entretiens menés par des intimes des personnes âgées).

Nous présenterons en première partie de cet article les caractéristiques langagières, cognitives et sociales du vieillissement dans son continuum jusqu'aux troubles cognitifs léger et pathologiques. En seconde partie nous développerons l'intérêt d'une approche multimodale sur corpus notamment pour renseigner l'accompagnement non-médicamenteux et enrichir les connaissances orthophoniques. Enfin nous présenterons le corpus depuis sa conception expérimentale à ses résultats

préliminaires qui concernent deux locutrices de l'étude âgées de plus de 75 ans et qui présentent un trouble cognitif léger.

Les conclusions générales indiquent qu'avec l'avancée en âge, les marqueurs pragmatiques verbaux revêtent préférentiellement une fonction interactive permettant ainsi aux personnes avec TCL de maintenir les relations intersubjectives avec l'interlocuteur. Par ailleurs, au niveau non-verbal, les manifestations gestuelles sont de plus en plus mobilisées dans le temps avec une préférence pour les marqueurs pragmatiques non-verbaux à fonction référentielle et à fonction interactive. L'une permettant de compenser les manques du mot, difficultés de planification, accros discursifs; l'autre optimisant et maintenant l'interaction avec l'interlocuteur.

Les cliniciens ont le devoir de développer leur pratique professionnelle par l'approche clinique basée sur des données probantes dont l'objectif majeur est de concilier la pratique clinique et les meilleures preuves issues de la recherche [Dollaghan, 2007]. Pour le cas de l'orthophonie, les cliniciens s'estiment très limités quant à cette approche [Lof, 2011; McCurtin, 2011] en particulier pour les patients avec TCL [Mungas *et al.*, 2010 ; Hopper, 2013 ; Morello, 2017] et plus spécifiquement lorsqu'il s'agit d'évaluer ou soutenir les fonctions langagières [Cummings, 2014].

L'approche en TCL nécessite des corpus longitudinaux pour comprendre i) les évolutions naturellement en œuvre chez les sujets, ii) renseigner l'implication de la réserve cognitive chez chaque individu et iii) tirer avantage de ces paramètres comme bases de données attestées pour la recherche et la rééducation précoce. Nous désirons montrer quels sont les avantages des méthodes d'investigation scientifiques linguistiques et interactionnelles à travers le vieillissement fragilisé, pour les professionnels de la santé et les aidants au quotidien.

Keywords: Corpus – Pragmatics – Multimodality – Mild Cognitive Impairment - Aging - Speech-Pathology

Mots-clés : Corpus – Pragmatique - Multimodalité – Trouble Cognitif Léger – Vieillesse - Orthophonie

Introduction

The monitoring of elderly patients with cognitive and physiological multifactorial disorders at home or in healthcare institutions, increasingly encourages caregivers to consider the language resources of these patients, while aiming at maintaining communication and promoting their autonomy in a benevolent and medication-free environment. Current assessment tools focus mainly on losses, particularly in the language system, with limited reference to language use and to the resources preserved by the elderly. Those gaps hamper the effectiveness of speech-language interventions which rely on levels of evidence still limited in scientific resources [Dollaghan, 2007]. Our study offers an overview of a multimodal analysis focusing on Mild Cognitive Impaired People by mining longitudinal corpus built on recorded intergenerational exchanges in ecological situation, with an emphasis on the identification of pragmatic markers. By definition, pragmatic markers (PM) are rooted in the discussion situation and aim to maintain discourse consistency [Brinton, 2010]. We propose an approach to language aging in a continuum ranging from normal to pathological aging, in which we identify a profile of people at the frontier of potential dementia.

We hypothesize that the identification of multimodal pragmatic markers, produced by people who are *a priori* at risk of developing dementia or of anchoring themselves in pathological aging, can help us to characterize inter-individual variations and significant compensatory communication skills in the aging process. We postulate that verbal and gestural pragmatic markers are relevant indicators for studying the subject's entrenchment in discourse [Davis & MacLagan, 2016; Duboisdindien & Lacheret-Dujour, 2017; Duboisdindien, Bolly, & Lacheret-Dujour, 2017; Hamilton, 1999]. We also consider the influence of interactional context on the use of these markers and what they can reveal about the emotional states and language skills of the elderly participant with respect to the proposed task:

autobiographical recollection of recent or past events. The aim of our study is not to determine a quantitative threshold of multimodal pragmatic markers for the diagnosis of dementia, but rather to give insights in what is at stake for elderly people with the use or misuse of these markers and their pragmatic functions all along the cognitive alteration.

We implemented the data processing following Kennedy's [1998] recommendations on the balance to be found between an ecological study (*i.e.* non-invasive and spontaneous), and technical constraints. In doing so, we obtained a sufficient representativeness of the studied population, comparability between the sub-components of the corpus and the proposed tasks, as well as interoperability between the tools in order to systematize the analysis. The data processing consists of 6 steps : (i) development of an interview protocols inspired both by those written in CorpAGEst [Bolly & Boutet, 2017] and our clinical experience, (ii) selection of participants, collection of field data for 14 months, sampling phase, digitization of video and audio data and their editing on the ORTOLANG scientific platform, (iii) transcription and alignment of audio data, (iv) annotation of audio and video data, (v) a unimodal and multimodal analyses of data, and (vi) systematic storage of original sources and annotated files.

All the tasks proposed during the semi-structured interviews as well as the collection protocol correspond to the framework imposed by the ethics committee of the Psychological Sciences Research Institute of Louvain-la-Neuve University in Belgium.

Our data include 20 hours of video recording corresponding to 36 interviews with nine speakers (mean age: 83 years; average score at Moca-Test: 20/30). After subsampling, we ended with a total of 6 hours (30 minutes per speaker) for this specific study. From the results of our first analyses on the multimodal communicative features that characterize language evolution in aging, we expect that verbal deficits are accompanied/compensated by an increase in non-verbal acts with a specialization of both verbal and non-verbal pragmatic functions.

The use of corpus in natural interaction informs us on different levels. The more complex the verbal content becomes, the more the elderly person uses referential and deictic gestures and intersubjective solicitations addressed to the interlocutor (signs of co-agreement, shared knowledge, interactive gaze) in order to keep communicating. This corpus delivers a different point of view compared to other investigations published so far on aging psychology and mostly based on data generated in laboratory conditions. Our approach allows us to grasp authentic interactions produced in natural exchange situations with their intrinsic complexity and enables a fine-grained functional analysis of productions in various modality. The project is in line with the work of C.T. Bolly [2013-2015], which focuses on healthy aging. The trends observed in this scope commit us to thinking of language as a resource for detecting dementia signs and understanding compensation strategies. Therefore, this work appears as an outstanding opportunity for clinical practitioners such as speech pathologists, physiotherapists, and psychomotor therapists to develop care protocols relying on verbal and non-verbal communication in aging. The significance of pragmatic marker functions in elderly speech, as well as approaches induced by linguistics and specifically pragmatics, contributes to broaden the urgent request to develop non-medicinal psychosociable methods, and evaluation tools for vulnerable old people to ensure their well-being.

The entire article is located at the following link :
Guillaume Duboisdindien, Cyril Grandin, Dominique Boutet et Anne Lacheret-Dujour, « A Multimodal corpus to check on pragmatic competence for Mild Cognitive Impaired aging people », Corpus [En ligne], 19 | 2019, mis en ligne le 01 janvier 2019, URL : <http://journals.openedition.org/corpus/4295>

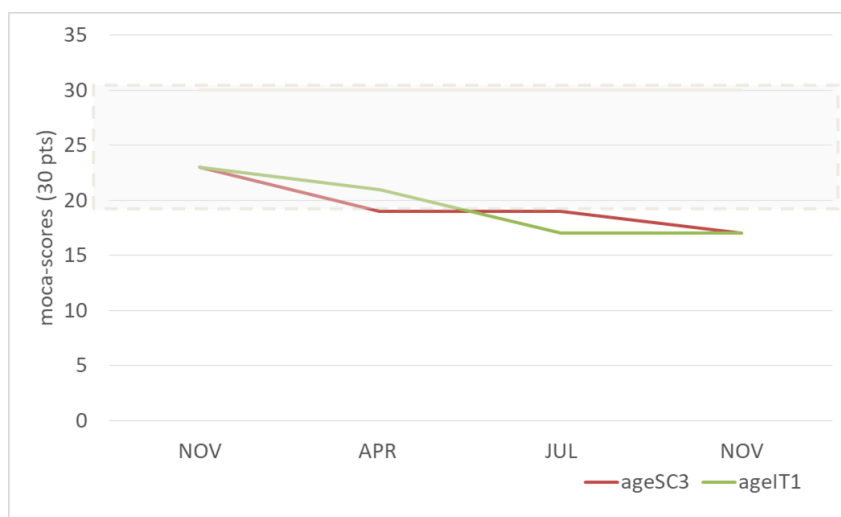
3.3. Results on two case studies:

Constance is an 86-year-old woman; she lives alone in her own home. After a few years as a cleaner, she stayed at home

to raise her children. Her sons and neighbors come to visit her daily. She does not require medical care and benefits from physiotherapeutic care. Mild cognitive impairment appeared about three years ago, according to her relatives. Her regular lapses of memory led the family to consult a neurologist in April 2015 who did not detect any dementia but concluded that the cognitive fragility was moderately worsening over time. Constance's predominant communication complaint is lexical deficits (word finding problems). The following graph shows the set of scores for longitudinal cognitive assessments conducted every 4 months.

As for Tristane, she is an 81-year-old autonomous woman. She does not require any special medical care. However, her family has alerted the general practitioner regarding memory issues affecting both discussions and daily life (forgetting recent discussions and family events: birth, death, marriage). The scores for the longitudinal cognitive assessments performed every 4 months are presented in the following graph. The medical diagnosis for Alzheimer's disease was given this year after two and a half years of follow-up (approximately every four months) with memory evaluation

There has been a gradual decline in the scores of the screening Moca-Test up to a problematic threshold. Complete neurological examinations were performed in April 2015 without revealing any AD or related syndrome. Constance is located in the clinical category of MCI patients.



Graphic 1: score results on longitudinal Moca assessment ageSC3 & ageIT1 during 15 months.

After exporting the VPMs data of the two speakers out from Elan, we first evaluated the quality of the corpus and validated it by carefully checking the presence and if necessary the well-foundedness of missing data.

The data set that can finally be used for analysis includes 3931 VPM distributed as follows:

	S1	S2	S3	S4	S5	S6	S7	S8
ageIT1	273	533	188	191	236	261	241	271
ageSC3	218	270	272	210	255	157	157	198

In order to smooth the “speaker” effect and to take into account a possible idiosyncratic differential of the verbal content (prolific subject vs. taciturn subject), we chose to work in frequency. Still with this concern of normalization and in order to minimize the effects of extrinsic co-factors (different emotional state between two interviews), we decided to proceed to a normalization in frequency by task.

Thus, for each speaker, the data will be expressed in frequency of use of each functional domain among all the VPMs expressed during a task.

General characteristics of the VPM device: Use of VM (in frequencies per task and speaker)

The figure below gives an overview of the data thus generated:

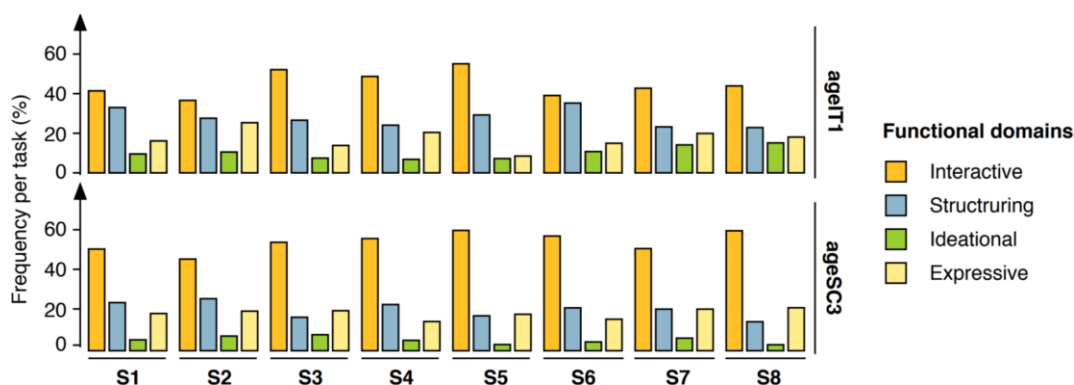


Figure 8 : General characteristics of the VPM device: Use of VM (in frequencies per task and speaker)

According to this first figure, we can observe:

- An extensive use of Interactive VPMs, whatever the speaker and the task considered (between 40 and 50% of VPMs used during a task) despite the progressive entry into the pathology.
- A pragmatic profile of VPM use generally similar between speaker and proposed task (in general, in order of frequency of use: Interactive > Expressive > Structuring > Ideational).

The interactive aspect prevails. Constance and Tristane use interpersonal VPMs to solicit the interlocutor and their shared knowledge in order to ensure interaction is maintained and remains anchored in discourse (in particular by inserting co-agreement VPMs). Thus, this situation of interaction disturbed

by language fragilities (naming deficits, disfluencies, doubts) is dealt with by the speaker but can also be dealt with by relatives if they are attentive to these indicators of cognitive discomfort. Once these elements have been identified, they could be valuable resource tools for clinicians in order to intervene at times when tiredness occurs or if the theme addressed requires a major effort in the exchange. These markers would alleviate the feeling of powerlessness of older speakers who could overcome the situation by transmitting a positive and committed image of themselves in speech. The clinician must be sufficiently sensitive to these interaction marks.

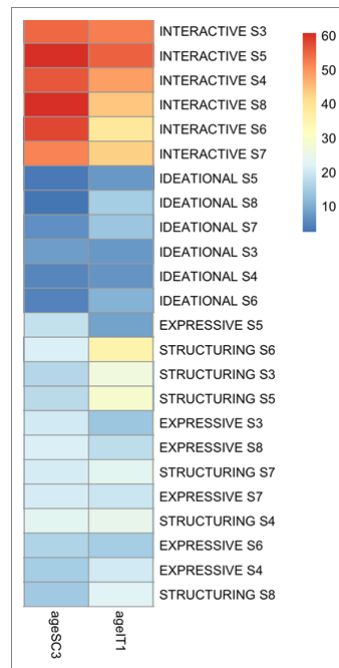


Figure 9 : Hierarchical clustering: Speakers vs. Use of VPM (in frequencies) per task

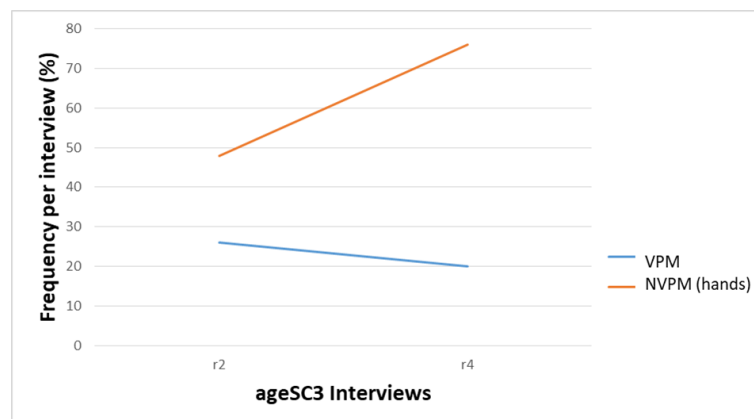
In order to characterize the system upstream, and to reveal any underlying structures, we then used a hierarchical clustering strategy (based on Pearson's correlation and Ward's D2 aggregation criterion), the idea being to graphically visualize the similarities and di-similarities between the different classes of

VPM according to the way they are used by the different speakers. The heatmap below presents the results of this analysis. For a given cell, the warmer the colour is, the more important the use of a class of VPM during a given interview is for the speaker in question (and vice versa when it is coloured in cold blue).

We see here (Figure 9) that:

- The interactive VPMs are generally more mobilized, whoever the speaker and whatever the exercise, when compared with the other classes of VPM, corroborating the previous observations.
- The way the interactive and ideational VPM types are used is relatively homogeneous across tasks.
- The structure is more unclear concerning the VPM of structuring and expressive types.
- AgeSC3 makes greater overall use of interactive VPMs
- AgeIT1 makes greater use of expressive and structuring VPMs.

In addition to this analysis, we also characterized non-verbal manifestations in Constance's speech. To do this, we counted the NVPMs (of hands) in r2 and r4, which allowed us to note an increase of 22% of NVPMs produced by Constance between these two interviews.



Graphic 2 : Frequency of VPM versus NVPM between interview 2 and interview 4 with ageSC3

Given these preliminary results, it remains to be seen whether NVPs would increase over time in seniors' discourse. In comparison, these NVPs are more numerous than the VPs produced within these two corpora. This finding may indicate a tendency for Constance to produce more gestures during interaction while verbal information content decreases.

In the third and fourth interviews, referential gestures tend to take a deictic orientation by taking precedence over representational gestures.

In an exchange about odor recollections, Constance is not able to name the stimulus, which is the smell of lavender. She explains to her son that she recognizes the smell but the word does not cross her mind. She ends up looking into her direct environment and pointing her finger at the bouquet of lavender placed in her kitchen while at the same time verbalizing her discomfort:

Constance : « *euh...comment... euh...* [pointing at the bouquet]»

Jules : « *de la lavande oui !* »

Constance : « *oui de la lavande c'est ça ... ah !* »

* Constance: “*hum...How can i...hum*” [pointing at the bouquet]

Jules: “*a bunch of lavender, yeah !*”

Constance: “*yeah that's it, a bunch of lavender ... ah !*”

(see illustration 1.b. in this article : *Example of a deictic gesture: pointing the bunch of lavender (in ageSC3_r3_S5-00:59)*)

In the light of recent studies [Schiaratura *et al.*, 2015; Carlomagno *et al.*, 2005] we assume that representational gestures are also becoming too cognitively expensive for Constance. Indeed, it is a complex activity that involves both semantic memory (*e.g.* encyclopedic knowledge, language, and concepts) and executive functions that govern the cognitive mechanisms required to perform gestures and fine motor skills. Moreover, the overall situation is stressful for Constance experiencing naming and frustration for several months. Yet willingness to communicate is still there but manifests itself in a simpler form.

Another interesting orientation concerns the developmental approach of communication throughout life. We can hypothesize that this duality between deficit phenomena and compensatory phenomena is to be analyzed under a retroactive light of human communication. During their development, young children gradually experiment with gesture and communication skills that will enhance their language acquisition. The development of referential gestures is gradually achieved through the deictics scale first (finger/hand pointing, joint attention and gaze designation), and then through ideational gestures that require greater cognitive skill and greater refinement on the semantic level as the young child develops his knowledge. During the aging process, and especially during the fragile and problematic aging, these gestural manifestations take the opposite path but always sign this need to communicate and share emotions. The cognitive stock could be involved in this process because it would contain all the neuronal capacities to cope with cognitive difficulties. Throughout their life experiences, the elderly have internalized a set of verbal and non-verbal behaviors that would allow them to compensate and maintain interactions in the event of difficulties in an individual-specific process. These attempts would be all the more valued and effective if the interlocutor, either close, clinician or all-coming, proves to be supportive and empathetic.

Conclusion

This study sheds light on a point of view differing from the classical investigation methods proposed so far in aging psychology (for the most part based on data produced in laboratory conditions). Our approach give room for the expression of authentic interactions in natural exchange situations that can be observed as closely as possible. Our study develops several innovative aspects. First, the pragmatic competence of elderly people with mild cognitive deficits is still a marginal topic in linguistic. Secondly, it proposes a methodology based on the reasoned and explicit annotation of multimodal data in natural spontaneous exchange situations, which can therefore be used for other research perspectives.

Third, the multidisciplinary dimension of this study, at the crossroads of pragmatics, discourse analysis, psychology of aging and multimodality, offers diversified avenues for the scientific community and - we hope - may encourage clinical research to develop corpus-based approaches. Indeed, the community is engaged in soliciting the humanities and social sciences for a better understanding of the language continuum and in developing clinical models favoring diagnosis and therapeutic support in an evidence-based approach.

We propose a continuous approach to language aging, and identify a singular profile for MCI people within this frame. The trends we highlight commit us to thinking of language as an interesting resource for detecting early markers of dementia. Without talking about pathological aging, it is necessary to observe the profiles of the participants in our study and to analyze the distinctions that exist between the common and heterogeneous pathways that they take over time. This has always been done after the diagnosis has been made. However, it seems crucial to carefully consider these pragmatic markers before the establishment of any obvious clinical signs in order to enrich research on pathological aging.

Finally, it is worth developing a multimodal approach to account for the non-verbal compensatory elements within the deficit elements of these MCI people.

At the end of this discussion on the communicational traits that would characterize this in-between profile in language aging, we postulate that verbal deficits are accompanied by an increase in non-verbal acts with a specialization of these non-verbal manifestations as the deficits increase. The more verbal content becomes difficult to represent manually, the more the elderly person relies on deictic gestures and intersubjective solicitations addressed to the interlocutor (signs of co-agreements, shared, interactive knowledge) in order to maintain the communication.

In a long term perspective, considering language in its plural dimension offers a relevant anchorage as soon as we build interactive corpuses. We have seen that speech in action is usually accompanied by communicative gestures. Follow-up

researches on this topic would be beneficial in order to point the compensatory or facilitating nature of the gesture within the disturbed language, and to identify possible predictors of dementia like Alzheimer's disease (AD). AD is characterized by a progressive deterioration of intellectual abilities, memory loss, attention difficulties and language disorders (particularly at the semantic level). The person's deep identity is altered, accompanied by behavioural and mood disturbances. These changes alter communication skills and disrupt not only the patient's life, but also social relationships.

Currently, the few studies addressing these questions (Glosser & Barnoskir, 1998 ; Taler & Philipps, 2008 ; Schiaratura, 2008 ; Taler, Baum, Saumier, & Chertkow, 2008 ; Davis & MacLagan, 2016) engage research to develop models considering the communication of the elderly with TCL or MA: i) in its multimodal dimension i) interactive ii); iii) and in approaches toured on its manifestations at the level of discourse and more generally at the level of the pragmatic and social dimension. We emphasize the importance of considering non-verbal communication in its interactive dimension in people with LCH. If non-verbal and adaptive cues are not perceived by the interlocutor within repeated daily activities - care, meals, friendly exchange, activity - then the person is less and less likely to interact in this modality, at the risk of increasing the symptoms a little more by the effect of social and emotional comorbidity.

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