



Master Thesis Project

Double-degree Università degli Studi di Padova-Universidad de Granada

Cognitive Neuroscience and Clinical Neuropsychology

***Breakfast for You task (B4Y): Preliminary
evidence from the development of an interactive
and ecological task for the assessment of social
cognition***

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*A quello che l'Università di Padova mi ha permesso,
to what the Boston University has shared with me,
y a lo que la Universidad de Granada me ha regalado.*

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Abstract

In the field of social cognition, the lack of ecological validity for the assessment procedures used in clinical practice is a recurrent obstacle. The classical static materials commonly used do not seem to accurately reflect the dynamic behavioural interchange occurring between people in the real-world, complex contexts that characterize social cognition. Consequently, researchers are now acknowledging the need for stimuli that are more dynamic, multimodal, context-embedded, and socially interactive.

On this basis, the present study aimed to design a novel assessment tool that incorporates real-life scenarios and dynamic interactions between the subject and the researcher: The *Breakfast for You* (B4U) Task. We particularly sought to obtain preliminary evidence from a group of healthy young participants to initiate the validation process of the task, which framed social cognition in the context of daily life activities.

By incorporating innovative variables tapping into components of social cognition (emotional recognition, ToM, and perspective taking), the study successfully demonstrated the convergent validity of B4U when compared to more traditional measures of social cognition. Furthermore, we achieved divergent validity by obtaining a genuine measure of pure social cognition disentangled from broader cognitive functions. Finally, we obtained evidence for ecological validity for a specific subcomponent of the ones assessed.

Even if we lacked the appropriate statistical power to generalize our findings, the B4U task holds promise as a valid and ecologically sound assessment tool for social cognition if further implemented and refined with larger samples and extended to diverse clinical populations.

Introduction

Humans are innately social creatures, deeply embedded in a world where social life is crucial for the human experience. For this reason, social cognition which is the means by which we perceive, process and interpret social information is considered a fundamental neurocognitive capacity that allows individuals to perceive and make sense of social cues, emotions, intentions, beliefs and desires of others.

For these reasons, many researches have in fact demonstrated that social cognition is not only linked to social relationships but also to the individuals' well-being; in fact, it has been demonstrated that social appropriate abilities help experiencing a sense of belonging and connectedness leading to a higher life satisfaction on one hand, reducing the risk of depression, anxiety and loneliness on the other (Henry et al., 2015, Msika et al., 2022).

As a consequence, when social cognition aspects are affected, the impairments are often considered to be more incapacitating than any other cognitive deficits, also influencing and affecting the individual's relatives and/or caregivers' lives in the most severe cases (Rodriguez et al., 2010). For this reason, alterations in social cognition are recognized and recently included in the most recent Diagnostic and Statistical Manual for Mental Disorder (DSM-5), which acknowledges such impairments as part of the six core neurocognitive domains for Neurocognitive Disorders. By including social cognitive impairments in the diagnostic criteria, the DSM-5 highlights the importance of assessing and addressing social cognition to understand and treat these conditions effectively.

However, even if the consequences of social cognition deficits are straightforward, the notions behind social cognition are far from simplistic: it is in fact a multiple domain concept that embraces several subcomponents which can be individually or jointly affected depending of the etiology of the disease (Samson et al., 2007).

Therefore, the aim behind the following paragraphs was to carefully analyze the scientific literature relevant for the topic at hand and give a brief overview about both the the different subcomponents and the pathological aspects of the social cognition; to give the reader a general theoretical framework to better understand the purposes behind our study.

Components of social cognition

As we have seen, socio-cognitive skills are crucial for successful interpersonal interactions; however, as Yager and Ehmann (2006) demonstrate, social cognition is just an umbrella term that reflects a broad variety of psychological processes.

Those processes can, in general, be easily distinguished between lower-level and higher-level social cognitive mechanisms (Mitchell and Phillip, 2015).

The former involve the basic, automatic and relatively unconscious cognitive courses of actions that occur when we perceive and categorize social information. They include processes derived from joint attention, emotional perception and judgements based on non-verbal or speech cues such as for example facial expressions. In contrast, the latter refers to more complex and conscious cognitive processes that serve to integrate and interpret such cues in order to infer the mental states of others (such as others' feelings, thoughts and intentions). They involve perspective-taking, empathy and theory of mind (Arioli, 2018).

a) Social perception

Social perception can be defined as “the identification of emotionally salient information in the environment: verbal and non-verbal cues (behavior, facial and bodily expressions) that a person uses to form opinions or make inferences about the emotions of other people” (Mitchell & Phillips, 2015). In other words, we can say that it is the process that encompasses the initial stages of social cognition, where individuals extract and make sense of various cues to form impressions and make judgements about others. Because this is one of the most basic and automatic processes of social cognition (low-level), emotion perception is one of the most commonly assessed domains in individuals.

Mitchell & Phillips (2015) have demonstrated that even in the simplest subcomponent of social cognition, the social perception one, there is the influence of one of the main important and complex functions: attention. In fact, they demonstrated that individuals during an interaction, share attentional mechanisms (more generally called joint attention) which allow to selectively attend to objects that are mutually interesting.

It is in fact, commonly believed that such mechanisms act as “gateway” to the more higher-level social processes such as those involving ToM mechanisms as we will now see. As a consequence, even if it might seem a basic/low-level component, we can consider social perception as a previous and necessary step that leads to effective ToM performances both from a temporal and a processing order point of view (Mitchell & Phillips, 2015).

b) Empathy

Another very important component of social cognition but instead considered to be part of the high-level processes is empathy. Empathy is defined as the ability to identify and share the emotional states of another’s person (Wallis et al., 2021).

Empathy involves both a cognitive and an affective component. The former is also most often referred to as perspective-taking and it involves the capacity to understand the point of view of another person. It is considered a higher-level cognitive process because it requires mentalizing and inferring someone else’s perspective (Arioli, 2018).

On the other hand, the affective component involves the processes of sharing and personally experiencing the emotional states of others: it enables individuals to feel and respond to the emotions displayed by others.

Empathy seems essential for building and maintaining social connections, as it fosters understanding, compassion and prosocial behavior (Beadle et al., 2019)

c) Theory of Mind (ToM)

The core component of social cognition however, seems to be the Theory of Mind (ToM) namely: “the ability to attribute mental states such as belief, emotions, desires and intentions to others, appreciate that these mental states might differ from our own and use this knowledge to predict and explain behavior/actions” (Wallis et al., 2021). A recent theoretical framework suggests that a “good ToM” involves both taking someone else’s perspective while at the same time inhibiting one’s own belief: a process that depends on executive functions (Le Bouc et al., 2012; Samson, 2007). Samson and her colleagues (2007) were interested in distinguishing to what extent the two components of ToM (taking someone else’s perspective and inhibiting one’s own) are specific to the social domain or are, instead, part of more general executive functions’ processes. From

their work, it appeared that those two subcomponents were specifically associated with lesions to different brain areas (respectively, the right inferior frontal gyrus and the left temporo-parietal junction), suggesting that they are distinct neuronal processes. As a consequence, Apperly et al. (2005) implied that it's quite plausible that different ToM components rely on different combinations of executive functions and that such patterns might explain the different performance profiles across social cognition tasks. For this reason, it seems necessary to develop social cognitive tasks that are able to disentangle the social cognitive components dependent on executive functions from those which are not. As we will see later, this was one of the aims behind our present research.

Social cognitive neuroscience has further defined two main subcomponents of ToM: cognitive ToM which requires an understanding of others' cognitive states, beliefs, thoughts and intentions, which in more general term implies understanding that individuals have different perspectives and/or beliefs compared to ours; and affective ToM which requires an understanding of others' emotions, affective states or feelings empathizing with the subject in question, in this case for a proper interaction, it is necessary to inhibit our own self-perspective (Allain et al., 2020).

It is worth mentioning that even if they are often described as separate entities, cognitive and affective ToM are strictly interconnected and influence each other in real-world social situations.

Neural correlates of social cognition and alterations in neurological disorders

Normally, the distinct disturbances of social cognition have been linked to abnormalities in specific neural regions: for example, lesions in the orbitofrontal cortex are associated with disinhibited behaviors, or lesions in the temporoparietal junction to inability to view a situation from another person's perspective (see Henry et al. 2015). However, such a complex cognitive ability does not seem a likely candidate for a certain localization, but rather a neural network or circuits is more plausible (Stone et al., 1998), leading to a concept of disruption of interactions within and between larger scale networks instead. However, we can definitely say that brain areas such as the prefrontal cortex, the posterior cingulate cortex and the bilateral temporo-parietal junction, as neuroimaging studies demonstrate, are considered essential and responsible for the effective functioning of the different subdomains of social cognition (Arioli et al., 2018). In fact, the deficits' pattern observable in patients are not identical and commonly shared, but rather seems to be individual and characteristic depending on the etiology and brain localization of the disease.

For those reasons it's interesting to study social cognition also from a clinical point of view, in order to establish how the changes in these cognitive processes/behaviors lead to disorders of social functioning.

Given the large brain network responsible of social cognition, unfortunately, most neurological disorders that affect the brain have the potential to disrupt social cognition; and social cognitive impairment can therefore be a prominent clinical symptom after acute brain damage, such as traumatic brain injury or stroke, and can be a core feature of the early stages of some chronic neurological disorders, such as behavioral-variant frontotemporal dementia (Henry et al., 2015). These subjects, most of the time, have difficulty in emotion recognition, social perception, empathy, moral reasoning, social problem solving and mentalizing of theory of mind (ToM) abilities (Allain et al., 2020).

In any case, in the early stages of such illnesses, those disturbances might be subtle and relatively hard to detect as a consequence, it seems necessary to include an

exhaustive social cognitive assessment in the standardized neurological examination of those patients, as we will further discuss below. In such a way, the clinical data obtained could be used to clarify the nature, magnitude and specificity of social cognitive impairments by delineating commonly shared clinical profiles among patients.

Socio-demographical influences on social cognition

One of the most extensive research to study the influence of several socio-demographic variables on social cognition conducted by Sommerlad et al. (2021) highlighted some of the main socio-demographic characteristics influencing social cognition. In their study, the authors administered online to a large British sample the empathic concern and the perspective taking subdomains of the Interpersonal reactivity index (IRI, Davis, 1983), a self-reported questionnaire. Consistent with prior studies (see Henry, Phillips, Ruffman, & Bailey, 2013 for a meta-analysis), they found that increasing age had a significant impact on the decline of empathic abilities (Beadle and De la Vega, 2019). However, it remains a matter of debate whether this decline is solely attributable to the normal cognitive impairment associated with aging or if it is influenced by the life experiences underwent by the individuals.

Another relevant aspect that seems to affect social cognition is gender; with women showing overall higher scores in empathy scales than men (O'Brien et al., 2013). Interestingly, it has been demonstrated that even in females, social cognition abilities tend to slightly shift over the lifespan. There seems to be an increase in empathy up to the 40s and then a gradual decline from the age of 45 (Sommerlad et al., 2021).

In their study, these authors investigated the potential relevance of everyday social experiences related to caregiving or living with others, which could positively contribute to the development of social cognitive abilities. They found that those participants with caring professions, such as health professionals or educators, had higher scores on empathetic concern, while living status (i.e. living alone or with others) had no significant effect on their social cognitive measures. Additionally, the level of education was associated with both empathetic concern and self- perspective.

Social cognitive assessment: traditional tools

In addition to the conventional areas of neuropsychological evaluations, clinicians are now recognizing the importance of assessing the possible social and interpersonal deficits which might characterize their patients' lives (Arioli et al., 2018). Nevertheless, besides its relevance, social cognition is still infrequently evaluated with formal assessment methods (Kelly et al., 2017). In fact, in clinical practice social impairments are typically inferred from general neuropsychological measures which do not fully detect or accurately characterize the true nature of social cognitive abilities (Godfrey and Shum, 2000), or rely on subjective tools created by the therapists themselves and thought to be ad hoc for the specific subgroups of patients being evaluated (Wallis et al, 2022).

Consequently, there is a need to establish appropriate methods of assessment that can identify the different domains of social cognition in different types of patients. This, would facilitate the development of a standardized social cognitive battery that will enable an objective quantification of the severity of impairments and the possible identification of residual abilities that could compensate for such deficits (Wallis et al., 2022).

In a recent review, Eddy (2019) identified 76 different measures of social cognition which, for obvious reasons, won't be completely covered by this work. Instead, only those

measures of better quality and relevance for the present study will be briefly described and further discussed.

A common classification of the measures used in the social cognition field distinguishes between subjective or informant-rated scales and more traditional performance-based tasks or tests. Within the first category (the subjective and/or informant-rated scales) some frequently used scales with good psychometric properties include the Empathy Quotient (EQ) scale (Baron-Cohen, 2004), which measures both cognitive and affective empathy, and the Frontal Systems Behavior Scale by Henry et al. (2015), designed to measure the social behavior components particularly in patients affected by frontal lobe damage. In addition, we can also give credits to the Socioemotional Dysfunction Scale by Barsuglia et al. (2014) classified as a valid self-report measure of adaptive social behavior.

Those scales are considered highly reliable and can also be compared with information deriving from the patients' most closed family members and/or caregivers such as those collected in questionnaires like the Frontal Behavioral Inventory scale designed by Kertesz et al. (2000). The main role of self and informant-rated scales is to provide clearer insights on the patients' socio-cognitive abilities in real environments.

However, there are some limitations with the use of self/others reported questionnaires or scales that need to be taken into account. In fact, these scales are susceptible to the social desirability bias or by potential anosognostic deficits deriving from the patients' diagnosis. Similarly, caregivers may under or over-estimate the actual clinical condition of the patient. Therefore, the results that the clinician is able to obtain might be somehow biased and not always be correctly reflective for the cases at hand.

As a consequence, in most occasions it is necessary to employ performance-based social cognition tests that eliminate such subjective biases and directly reflect the objective performance of the patients in more reliable conditions aimed at resembling what happens outside of the clinical environment.

Among such tests, one of the most reliable and widely used test is the *Faux Pas Recognition Test* (Baron-Cohen et al., 1999) which is focused on measuring ToM abilities in healthy and impaired individuals. To correctly perform such test, the patient is required to possess an appropriate and functioning level of social reasoning which might not always be the case. Similarly, the Strange Stories test by Happè (1994) which also measure the individual's ToM, places a particular focus on the ability to disregard one's own knowledge to consider that someone else might have a different belief (Henry et al., 2015). The Multifaceted Empathy Test (MET) is another well-known test aimed at discriminating mental state from subjective emotional response, especially in people affected by autism (Henry et al., 2015). It measures both cognitive and emotional components of empathy and can be used in support of the EQ scale previously described.

As mentioned earlier, deficits in low-level social perception often manifest as difficulties in recognizing others' emotional facial or body expressions. As a consequence, to measure this specific subcomponent one of the most commonly used test is the Ekman Faces (Ekman and Friesen, 1976), which present static photographs of the six basic facial expressions (disgust, anger, fear, surprise, sadness, happiness and neutral) to assess the patients' ability in the recognition of facial expressions of basic emotions. Another highly reliable test commonly used is the Reading the Mind in the Eyes Test by Baron-Cohen (2001), that consists of presenting photographs of human eyes which have to be associated to words that describes what the person is thinking/feeling. This test

has been associated as a medium-level social cognition test that seem to measure something in between emotional recognition and ToM (Sunahara et al., 2022).

Evaluation of social cognition with more ecological tools:

The tests described above, such as the Faux Pas or the Strange stories tests have been shown to have a common limitation given their reliance on static and decontextualized materials (i.e. use of photos, cartoons or written description of social interactions). Many researchers have therefore recently highlighted the lack of ecological validity in these traditional measures of social cognition and the need for new tools that approach more realistic social situations (Achim, Guitton, Jackson, Boutin, & Monetta, 2013; Osborne-Crowley, 2020), as we will explore below. Additionally, these traditional tests are typically influenced by other cognitive processes such as memory or global cognitive status, probably due to the way the material is presented (with long texts describing the social situation, limited contextual information or simplistic vignettes drawings, and sometimes recreating situations that might be far from the individuals' activities of daily living). This potential lack of divergent validity can be problematic when trying to isolate potential social cognition deficits in patients that already have problems in other cognitive domains, such as for example in cases of normal cognitive deterioration, dementias or brain damages.

We therefore wonder whether new tools instantiated in more familiar settings with contextual cues might be more adequate to assess social cognitive abilities in a more fine-grained basis.

Ecological validity refers to the extent to which the findings of a study accurately reflect real-world phenomena (Osborne-Crowley, 2020). In order to accomplish this goal, the stimuli used in researches should resemble those that people encounter in their everyday life, otherwise, we can't be sure that the responses observed actually generalize to real-world settings. Similarly, also the responses asked to participants by researchers should mirror those that are normally demanded, otherwise the generalizability construct won't be met (Osborne-Crowley, 2020). For these reasons, social cognitive researchers should move toward the use of stimuli that are more dynamic, multimodal, context-embedded and interactive (Allain et al., 2020).

In fact, Murray et al. (2017) in his work, demonstrated that video-based assessments of theory of mind were superior compared to the more standardized social cognitive tests that we discussed in the previous section.

For this reason, in an effort to develop more ecological tools to measure social cognition, several researchers have recently developed new tests based on technological advances that present social situations to be evaluated by the participant through dynamic stimuli presented with videos or virtual reality. Some examples of these are *The Awareness of Social Inference Test (TASIT; McDonald, 2003)* or the *Movie for the Assessment of Social Cognition (MASC; Dziobek et al., 2006)*. These tests present videos of naturalistic everyday ambiguous social interactions (depicting emotions representations, sincere vs sarcastic exchanges, lies, complex expressions etc.) among different characters, and participants are requested to interpret the scene, identify the meanings behind the interactions and answer questions about the actors' intentions, thoughts or feelings for the all duration of the videoclips. Many studies validating these tools in different cultures and patients have proved to have convergent validity with traditional social cognition measures and to be less dependent or less confounded than traditional tests on other cognitive processes.

Nevertheless, even if those types of tests certainly improve ecological validity under certain extent, they still constitute “third-person” perspective protocols, where the participant acts as a mere observer of others’ interactions, and only have to evaluate the thoughts and/or feelings of other people, without actually interacting with them. Nonetheless, in real life, social situations are not individualistic or seen from outside, but rather involve a dynamic exchange of information and actions between people. Therefore, many researchers are recently acknowledging the need to develop “first-person” everyday life scenarios tasks with real interactions to better identify the real-world phenomena of social cognitive functions (Byom & Mutlu 2013; Osborne-Crowley,2020).

However, even if this seems a prominent goal in the scientific community, at the moment, we are not aware of any test where participants are engaged in real social interactions within the context of familiar everyday life activities (ADL).

Aims of the present research

Based on what said so far, we therefore acknowledged the need of ecologically valid and first-person interactive tools to measure social cognition. In relation to that, the Neuropsychology and Activities of Daily Living lab at the CIMCYC have large experience developing ADL scenarios to assess different cognitive processes like executive functions, memory or monitoring processes (Merchán-Baeza et al, 2020; Ricchetti et al, in press, Rodriguez-Bailón et al, 2017; Salazar-Frias et al, 2023).

Recently, several members of this lab have initiated a project to develop ecological assessment tools to identify both low-level and high-level social cognition components from a first-person perspective, with real interaction, and contextualized in significant and familiar daily life environments.

In addition, the project aims at developing tools capable of distinguishing genuine social cognition components from other cognitive deficits such as memory or global cognitive abilities. Once validated in healthy participants, such a tool could be of great help in the future identifying different patterns of deficits in neurological patients with acquired brain damage, Multiple Sclerosis, different types of Mild Cognitive Impairments (MCI), dementia, and other conditions.

As part of this project, the specific goal of the current Master’s thesis was to obtain preliminary data from a group of healthy young participants to initiate the validation process of one of the tools designed by members of this lab, concretely the so called “Breakfast for you Task” (the B4U task, Navarro-Egido et al., in preparation). The “B4U task” asks participants to prepare a breakfast for a confederate (the evaluator).

In the first part of the task, participants are required to help the evaluator in setting up the table with several food and drink items, as well as kitchen tools related to breakfast preparation. Importantly, the person is asked to pass these items one by one to the confederate, engaging in joint action. Moreover, some items may need to be rotated by the participants to favor a comfortable position “ready to use” for the evaluator (e.g. to pass a cup with the handle oriented towards the receiver). This phenomenon, known as beginning state-comfort (BSC, see Kopnarski et al, 2023 for a recent review), might reflect participants’ abilities to program their actions while taking into account the other persons’ needs (i.e. joint action). This could constitute a potential form of low-level social cognition effect that has been previously observed in healthy adults but which appears to be somehow impaired in individuals with Autistic Spectrum Disorder (Kopnarski et al, 2023). However, to our knowledge, so far this effect has only been tested with isolated

object, with small samples, with small set of stimuli and never contextualized within the execution of a real ADL.

Additionally, during the first part of the task, the evaluator introduces two interacting social conflicting situations (ie. social traps) that may require ToM abilities from the participant in order to be solved.

In the second part of the task, participants are required to prepare the actual breakfast for the evaluator with something to drink and something to eat. The participants must first find out the evaluator's preferences by asking the necessary questions, and then prepare the meal while avoiding the use of distractor items related to their own preferences for their typical breakfast (that were also present in the scene).

First, we aimed at investigating how social cognitive abilities derived from our task, compared to other more traditional measures, might be influenced by several socio-demographic variables such as gender and year of education. Next, the primary aim of the study was to analyze the convergent validity of several indexes derived from this new tool by comparing them with more traditional measures of low-level and high-level social cognition components and executive functions (convergent validity). Third, we aimed at determining whether the indexes derived from the B4U task and from more classical measures of social cognition are or not dependent on other cognitive abilities such as memory or global cognitive status (i.e. divergent validity). Finally, we aimed at testing the ecological validity of the new tool by examining how it relates to several social experiential factors such as experience in care-giving, living with others experience and/or global measures of social integration in the community.

Hypotheses and expected results

We expect to find a pattern of moderate and statistically significant correlations between the social cognition scores derived from our new ecological task (i.e. the B4U task, specifically from the beginning state comfort (BSC) sub-score, the total number of questions, and the social traps sub-score) with the results derived from a classic neuropsychological test of social cognition: the MINI-SEA. More specifically, we expect the Beginning state comfort index to be associated with low-level measures of social cognition from the MINI-SEA (such as the emotion recognition score). On the other hand, we hypothesized that the social trap and the number of evoked questions scores in the B4U task will be more closely related to high-level measures of social cognition, like the Faux Pas sub-score from the MINI-SEA, or even with executive functions.

Furthermore, we expected that our ADL indexes derived from the B4U task will show less dependence or associations with other cognitive processes such as memory or global cognitive status.

In terms of socio-demographic factors, we expect to find that women will perform better than men in our social cognition measures (consisted with previous studies). Additionally, we expected participants with higher levels of education to demonstrate superior performance.

Regarding the ecological validity hypothesis, we expect that performance on the B4U task will be positively correlated with scores obtained in the Social Integration Questionnaire, reflecting greater social integration. Moreover, we hypothesized our task to be positively influenced by factors such as the degree of caregiving experience the experience of living with others.

In conclusion, we think it is also worth mentioning that this Master's thesis project with its respective hypotheses was informally pre-registered with a written document on May

3rd 2023, between the student, the advisor and the research team; as suggested in the Master's guideline (see Appendix Part 1 for the actual document).

Methods

Participants:

The experiment was carried out on a group of 30 young healthy individuals, aged between 18 and 35. The majority of them were either university students or young researchers at the University of Granada. To be eligible for participation, individuals needed to possess a proficient level of Spanish comprehension and not suffering any neuropsychiatric disorders such as substance abuse or depression. In addition, participants who had low scores on the cognitive screening test (i.e. MOCA) together with impaired performance in the memory and Executive Functions test were excluded from the analyses. As a result of these criteria, one participant was excluded from the study.

Participants were recruited on a voluntary basis either through snowball sampling by the researchers or through the SONA platform, accessible through the Centro de Investigación Mente, Cerebro y Comportamiento (CIMCYC, University of Granada; https://ugr-cimcyc.sona-systems.com/default.aspx?p_language=ES). The SONA platform allowed participants to receive Experimental Psychology course credits in exchange for their participation. Once individuals expressed their intention to participate, they received comprehensive written information regarding the aims and characteristics of the research and, prior to the experiment, the informed consent was signed in the presence of the experimenter. The study was approved by the Andalusian Ethic Committee for Biomedical Research (see Appendix Part 2.).

The a priori sample size calculation was performed with G*Power (Faul 2009). Although we are not aware of similar studies using this kind of first-person perspective ADL tasks to measure social cognition, we based the calculation on prior studies using social cognition ecological tasks through video presentations (i.e. studies of convergent validity of the MASC and TASIT tests with traditional tests of social cognition) that reported mean moderate correlations of $r=0,4$.

Therefore, for one tail correlation analysis with the α^* set at 0.05 and $1-\beta^*$ set at 0.8 for a moderate population correlation coefficient of $\rho^* = 0,4$, a sample size of 37 participants was estimated. However, due to the limited time available and due to the fact that evaluation sessions and data analysis were highly time consuming, it was not possible to reach the sample size estimated.

Based on that, and given the time constraints of the research period of the TFM, we decided to try to obtain a minimum sample of 30 participants that is the minimum sample size recommended for pilot studies (Johanson, G. A., & Brooks, G. P., 2009).

Materials:

The study comprised two distinct phases: Phase 1 involved a traditional neuropsychological assessment of cognitive and social cognitive functions, while Phase 2 the administration of the novel performance-based social cognition task: the so called Breakfast for You task (B4U task).

In the first phase, the experimenter conducted a structured interview to collect the subjects' personal and socio-demographic information (health data, age, sex, education and occupation). Subsequently, several neuropsychological tests were administered to the participants. Those tests are part of the standardized paper-and-pencil assessments commonly administered to patients in clinical settings, and that particularly focus on social cognitive aspects and executive functions. In fact, each test was accurately chosen in order to assess the main cognitive functions that are thought to potentially affect the social cognitive processes of both healthy and neuropsychological patients. I would like to mention that some tests were administered for research aims that go beyond the goals of this Master's thesis; therefore, only the tests directly relevant for this work will be describe and analyzed.

The second part of the experiment instead, consisted of the administration of a novel B4U task designed by Navarro-Egido et al. (in preparation at the Laboratory of Neuropsychology and ADL at the CIMCYC (Granada). Its primary aim was to assess social cognitive abilities and executive functions within the context of real interaction in activities of daily living.

Structured interview about sociodemographic variables, caregiver experience and living with others:

Once participants visited the lab, right after having been explained about the aims of the study and right after the signing of the informed consent, they were interviewed in order to collect personal and sociodemographic information regarding age, gender, years of education, past and present working experience, any possible psychological and/or neuropsychological disorders and finally any medicines' consumption.

Besides those common and usually collected type of information, we also asked them to provide us their past and present experience in caring for others, by administering the following questions: *"Have you ever been/are you a caregiver for someone?" "If yes, for who and for how long?"*, *"Are you used to prepare a breakfast for someone?"* and *"If yes, with which frequency?"*.

The participants' answers to these questions were collected and later grouped together in order to create the total *caregiver experience index*. The scoring procedure was as following: we attributed 1 point to each individual who reported to have been a caregiver sometimes in their lifetime and another point to those subjects who also reported to prepare a meal for someone at least once a week. In such a way, the total score for the caregiver index ranged from 0 to 2, where 0 indicates the absence of caregiver experiences while 2 indicates a pretty high level of experience in taking care of someone. The same was made for information regarding "living with others". Participants were asked the following questions: *"Are you living with someone?"*, *"Do you have any brothers or sisters?"* and *"If yes, are they younger or older?"*.

Again, this information was grouped and coded together to create the *"living with others index"*. Similarly to the previous index, we attributed 1 point to each subject who reported to be living in close contact with someone (i.e. with room-mates, with family members or

in student residences) and another point to all those individuals who reported to have a sibling. Once again, the total score could range from 0 to 2 where 0 indicates the absence of living with someone experience and 2 indicates a high level of experience in everyday life private social interactions.

Neuropsychological measures:

Following the interview, participants were administered with the following performance-based cognitive tests.

Once again, as this study is part of a larger project, here I will describe in greater details only the measures relevant to answer the questions raised by my work.

a. Montreal Cognitive Assessment (MOCA)

The Montreal Cognitive Assessment (MOCA) - Spanish version (Delgado et al., 2019) it is a screening instrument to detect mild cognitive impairment in healthy and/or pathological individuals. It is a brief and easy administrable test to assess participants' cognitive resources and functions. The test is divided into 12 items that measure different cognitive domains: executive functions are tested with a trail-making test, visuospatial abilities with a 3-dimensional cube and a copy clock-drawing test, identification through a 3-item confrontation naming task, memory by a short-term memory recall task, attention with forward and backward digit tasks, with sustained attention task and a serial subtraction task, language with the repetition of two syntactically complex sentences, through a phonemic fluency task and a 2-item verbal abstraction task and finally, orientation in time and place is also measured by administering really specific questions.

b. Animal Semantic Fluency Test

The general and commonly known Semantic Fluency Test for the Animal Category (Rosen, 1980) was administered to measure the individuals' executive functions and access to semantic memory. The task consists in verbally naming as many words from a single category (in this case animals) as possible in sixty seconds. The test is scored by counting the number of correct unique semantic category items produced in the allowed time. If the subject names 15 or less animals within the time frame, this might indicate early stages of a cognitive impairment.

c. Aprendizaje Verbal España-Complutense Test (TAVEC)

The Aprendizaje Verbal España-Complutense Test (TAVEC, Benedet and Alejandro 2014) was administered to measure learning and memory. It particularly consists of different subtests: immediate memory, short-term memory (with and without semantic cues), long-term memory (with and without semantic cues) and long-term recognition.

The subjects are read a shopping list of 16 words intermixed but differentiated into 4 semantic categories (species, tools, fruits and clothes) and are informed to remember as many words as possible.

In order to get the learning curve of each participant, the list is read 5 times and participants are required to repeat as many words as possible each time. To create inference however, we also read them a second shopping list with 16 different words intermixed but again differentiated into 4 semantic categories. Subsequently the different

types of memory previously described are assessed and a general score involving omissions, false positives, the discriminability and the Sesgo indexes are calculated. One week to 10 days after the experiment, the participants were contacted by phone and their long-term memory was tested again and the same indexes were also calculated.

d. *The Ineco Frontal Screening Test (INECO)*

The INECO (Spanish version, Torralva et al., 2009) is a neuropsychological battery that includes items of traditional tests to measure executive functions. The task includes different subtests such as the Luria motor series, Conflicting instructions, Motor inhibitory control (Go-no go), Backwards digit span, Months backwards, Corsi Test, Proverb interpretation and Hayling Test. A total global score of maximum 30 points and a working memory index of maximum 10 points can be derived from it.

e. *The Five Digit Test (FTD)*

The FTD (Sedò, 2004) consists in four exercises, each of which contains 50 items. Those items are either digits or stars arranged in cards.

In the first exercise the participant is simply asked to read the digits in the fastest way possible without making errors. In the second exercise the participant is asked to count how many stars are represent in each card; in the third exercise subjects are required to count the numbers present in each card under an incongruent stroop condition and in the last exercise subjects are asked to rapidly switch between the previous conditions in a single task. In this case, those conditions are pre-established according to the color of the cards' borders.

The total duration of each task, in seconds, is considered as the score for each subtest. Accuracy instead is measured by the numbers of errors committed on each trial.

The test measures five indexes reflecting attention and executive functions abilities. Those indexes are, respectively: processing speed, selective attention, alternating attention, inhibition abilities and switching abilities.

f. *Mini-Social Cognition and Emotional Assessment (MINI-SEA)*

To measure the social cognitive processes, we administered the MINI-SOCIAL COGNITION & EMOTIONAL ASSESSMENT (MINI-SEA) -Spanish version- (Clarens et al., 2021; Quesque et al., 2022) aimed at detecting possible impairments in social and emotional cognition. This test is a short form of the famous SEA (Funkiewiez et al., 2012) which is one of the most commonly and normally used tests to assess social cognition.

The MINI-SEA which lasts about 30 minutes, is consisted of two shortened sub-tests of the original SEA task: the facial emotion recognition test deriving from the Ekman Faces Task (Ekman and Friesen, 1976) and a shortened version of the Faux Pas Recognition Test (Baron-Cohen et al., 1999).

During the first part, participants view 35 images of facial expressions and are asked to select the emotion expressed in the image (i.e. happiness, surprise, neutral, sadness, disgust, anger or fear). The percentage of the correct answers is then calculated.

The faux-pas recognition test instead, is aimed at measuring ToM through 10 short stories about social situations, accompanied by their illustrations. After having read the stories, participants were asked to identify the presence of a social faux-pas by answering questions like "Who said something awkward?" or "Why shouldn't she/he

have said that?" etc. However, only half of the stories contain a faux-pas and the total score is calculated by attributing scores to every correct answer for both the faux- and the no faux-pas stories.

g. Community Integration Questionnaire

We also administered the COMMUNITY INTEGRATION QUESTIONNAIRE -Spanish version- (Rintala et al., 2002), which is a self-administrated scale that measures the degree of independence and social integration of a person in the community. For the aim of the present research however, we only focused on the social integration section of the test, which consisted of the six questions about the ease and frequency with which the person participate in social events (see Appendix Part 3.).

In the following Graph 1. we can summarize the types of variables of interest that were assessed during the first part of the study.

Graph 1. MEASURES OF INTEREST INCLUDED IN THE FIRST PHASE OF THE STUDY :

SOCIODEMOGRAPHICAL VARIABLES

- 1. Age**
- 2. Years of education**
- 3. Sex**
- 4. Social caring experience index**
- 5. Social living with others experience index.**

NEUROPSYCHOLOGICAL VARIABLES

- 1. Global cognition (from MOCA total score)**
- 2. Composite of Executive functions (from FTD score and INECO total score)**
- 3. Memory Composite (from TAVEC recognition and delayed free recall scores)**
- 4. Social cognition (scores derived from the MINISEA subtests)**
- 5. Social integration (subscore from the Community Integration Questionnaire)**

The Breakfast for You Task (B4U task)

The central and second part of the study consisted in the administration of a novel performance-based social cognition task, conducted in first-person perspective and set within the context of daily living. This task, "The Breakfast for You Task" (B4U task, Navarro-Egido et al., in preparation) was specifically designed by researchers from the Neuropsychology and ADL laboratory at the CIMCYC. It's objective was to measure several social cognitive abilities within the context of a significant and ecological task where the participant performance includes real interactions.

With this task we aimed at observing several components of social cognition, ranging from low-level to high level ones (i.e. social perception, joint attention and action, perspective taking or self-perspective inhibition).

Participants were instructed to prepare a breakfast for the experimenter, which included both something to drink and something to eat, according to the experimenter's preferences. However, these preferences were not explicitly provided, but instead had to be deducted by the participants through a series of questions (more details below).

“The Meal preference” questionnaire:

A self-administered questionnaire was sent to participants around one week before performing the B4U task, and its completion was a prerequisite for participants to be part of the research. This questionnaire was created by the team of researchers from the Neuropsychology and ADL lab for the purposes of this project and included a brief survey composed by 22 questions regarding the subjects’ preferences around different meals (for further information consult the Appendix Part 4.).

The responses were collected online by using the Lime Survey program through its access with the University of Granada. Participants could easily open it with either a personal computer or an electronic device.

Based on participants’ answers to this questionnaire, we individually designed the task for each subject beforehand, so that the breakfast to be prepared for the researcher was opposite to individual’s preferences. For example: if the participant responded that his/her favorite/usual breakfast consists in drinking a coffee while eating a jelly toast, we expected and guided the individual (if questions were made) to prepare a milk with chocolate and a toast with tomato’s sauce.

As a consequence, on the table there were both the items necessary to prepare the researcher’s breakfast (considered the “target items”) and the items related to the participant’s preferred breakfast (considered “distractors items”). In general, the total number of target and distractors was kept constant among participants.

Procedure

The B4U task comprised two distinct parts that allowed us to measure different social cognition and cognitive indexes.

The first part consists of arranging the table with all items related to breakfast preparation, and the second part focused on actually preparing the preferred breakfast for the evaluator.

Initially, the participants were asked to help the experimenter to organize the table by passing a series of objects. These items consisted of 7 target items, 7 distractor items and 9 non-breakfast items (see Appendix Part 5. for the types of objects). All the objects were placed inside of a box, retrieved one by one and handed over to the experimenter, who arranged them on the table.

To assess the “*beginning-state comfort*” score, (*BSC*), a subset of items in the box were deliberately placed in awkward orientations that required to be rotated by the participant for the receiver to get them in a comfortable position. For example, some objects were misplaced upside down and had to be rotated of 180° by the participant, to be passed on in a comfortable position (i.e. by the handle, by the clean part, etc). Appendix Part 5. also provides the number and types of objects that were included to obtain the BSC score (for scoring details, check the Scoring system for the B4U Task section below).

Also, within the first part of the B4U task, we included two social conflicting situations referred to as “*social traps*”, where the researcher required assistance from the participant. More concretely, we introduced two situations: the “napkins’ trap” and the “extension cord’s trap”. In the former, the researcher needed to find the napkins to clean a dirty utensil passed by the participant, while in the latter case the researcher needed to find an extension cord to plug in the toaster. These two items were placed outside the evaluator’s view but they are completely visible from the participant’s view.

To transmit the difficulty in needing/finding these items, the evaluator used facial gestures such as head and eye movements to express her needs of finding something. If participants did not display any effort or signs of understanding the evaluator (e.g. remaining motionless without attempting to assist), the evaluator would further provide a first verbal implicit cue, indicating that the spoon was dirty or that the cord was too short. If the participants still did not show any useful responses, a second explicit cue was further provided, explicitly stating "I need napkins/extension cord".

The participant behaviors were assessed based on the degree of help he/she expressed to solve the social trap (for more details check the scoring section below).

We consider this interaction a measure of theory of mind, as participants needed to understand the contextual situation and the evaluator's perspective, which differed from their own, in order to solve the social traps. Notably and in favor of ecological validity, this task deviated from more traditional ToM tasks, such as the Sally and Ann task or the director task, by embedding it within the context of a significant and real interaction instead of mere observation. Once all objects were arranged in the table (see Appendix Part 5.), the first part of the B4U task finished.

The second part of the B4U task consisted in the actual breakfast preparation for the evaluator. Once the objects and ingredients were all placed on the table, the following instructions were given to the participants: "Now, with the objects present on the table, I would like you to prepare a breakfast for me with something to drink and something to eat. You can use whatever you want that is on the table, you can move around and you can also move objects as you like". After having provided those instructions, we asked participants to repeat them to us in order to check whether or not they understood the task. This step is essential, in order to make the participants understand that the breakfast is specifically for the experimenter and not rather a general breakfast. At this point I let them know that they can ask me questions during the whole procedure, but that I am only allowed to answer with "Yes" or "No" to their questions.

Once ensured that they understood the required task, I asked them how they think they would make the task, by providing them a paper with the following options: 1. I won't be able to accomplish the task 2. I will accomplish the task but committing a lot of errors 3. I will accomplish the task but committing some errors 4. I will accomplish the task but committing few errors 5. I will perfectly accomplish the task without errors. Subsequently, I questioned them about the possible difficulties that they think they will encounter during the task and I collected them on their portfolio. Once the task is explained and all the information are collected, they were informed that they could start preparing the breakfast.

It is important to keep in mind that the meal that I wanted them to make consisted in their opposite preferences, previously collected with the online questionnaire "*The Meal preference*". This was done in order to make the task more difficult in terms of self-perspective inhibition requirements.

Finally, we again asked participants to rate his or her own performance with the same scale previously presented. The main aim behind this scale was to observe the level of Self-Awareness of their own social cognition abilities and other cognitive functions involved in ADL functioning.

During the B4U task, participants' performance and its interaction with the evaluator was video-recorded with an external camera for later analysis. In addition, during performance participants wore the Tobii Pro glasses (<https://www.tobii.com/>) which are portable eye-tracking glasses which record a person's eye movements, gazes and

fixations in ecological settings. In addition, they accurately measure pupil dilation: a proxy for cognitive effort (van der Wel and van Steenbergen, 2018). We used the eye tracking recording derived from the Tobii system in order to complete the scoring of the task (i.e. the beginning state comfort score and the others' perspective social trap score) when the external camera recording was ambiguous. However, the detailed analysis of the data collected with this software such as number and duration of target and distractor object fixations won't be included in this Master thesis project given time restrictions. The scoring procedure of this task is mainly based on analyzing the videos of the participants' performance. For the detailed scoring procedure see the following section.

Scoring system for the B4U Task

We have developed a scoring system for each of the observable components of interest from the B4U task, which is as follow :

- *Begging state comfort (BSC) scoring:* The scoring system applies to the first part of the task, when participants are required to take the objects present in the box to pass them on to the experimenter. The scores were as follows: 0 points were assigned to the participants who did not rotate at all the objects and passed them to the experimenter in the same awkward position with which they were placed in the box, 0,5 points were attributed to those participants who rotated the objects at least for 180° degrees and 1 point was assigned to the participants who perfectly achieved the optimal beginning-state comfort position for the experimenter (for more details please refer to Appendix Part 6.). Based on the number of rotatable objects for the beginning state, and the scoring assessment just provided, each participant could achieve a minimum score of 0 up to a maximum score of 12 which was later transformed into a percentage score over 100%.
- *Social Traps scoring:* The scoring system for measuring this component was as follows: we assigned 3 points to those individuals who understood/started to search for a solution from the beginning, without the need of any cues, 2 points when they started searching after the first verbal cues, 1 point when they started searching after the second cue and 0 when they simply did not show any support to the experimenter's needs. Given the total number of the social traps and the scoring procedure, each participant could therefore get a range of scoring from 0 up to 6 points (100% for optimal performance).
- *Number of Total Questions:* to measure the other self-perspective component of theory of mind, we counted the number of *necessary questions* that participants spontaneously asked to find out what kind of breakfast the experimenter wanted. Taking into account the ingredients and objects available on the table, and the need to prepare something to drink and something to eat (specified in the instructions) we have established at 12 the number of questions necessary to correctly perform the task. Examples of such questions are: "Do you prefer whole milk?" or "Would you like a coffee?" In addition to them, we also counted the number of extra or secondary questions. Within this category we included questions about details of quantity and quality that might be asked by some participants during the breakfast preparation. These were considered secondary

because they were not necessary to achieve the task. However, because they might also relate to social cognition abilities such as worrying or interest about the very specific preferences of the other, we also summed them on the Total questions score

Plan analysis

First, we will analyze the inter-rater reliability of the B4U task. To do so, 4 different researchers involved in the project (me among them) will individually analyze the participants' performance of 10% of the total sample (randomly selected) and the responses collected among evaluators will be compared and analyzed in order to calculate their reliability, through the Intraclass Correlation Coefficients (ICC), for the main indexes derived from the B4U task.

Secondly, we will test whether the main variables from the social cognitive tests, the MINI-SEA, and the B4U task were or not normally distributed. To do so we will use Shapiro-Wilks test. Based on the result from this analysis, parametric or non-parametric tests will be used.

Third, we will provide descriptive statistics such as mean, standard deviation and range about relevant socio-demographic variables of the sample such as age, gender and years of education. We will also describe the experience of caring others, and of living with others.

Fourth, if the sample will have sufficient variability in the socio-demographic variables, we will conduct several analyses to test for potential associations and differences in the scores derived from the social cognition tasks included in this study (both the MINI-SEA and the B4U task) according to age, years of education and gender.

Fifth, as the main aim of our study was to test the convergent validity of this new tool for measuring social cognition, we will perform several correlational analyses between the indices derived from the B4U task with the classical neuropsychological paper-and-pencil tests of social cognition (i.e. variables derived from the MINI-SEA test) and with measures of EEFF (i.e. the five digits-inhibition and the INECO frontal screening). If any socio-demographic variables were highly correlated with the scores derived from the B4U task, additional correlation analyses will be conducted controlling for these variables (i.e. partial correlations). Also, in order to test if the B4U task is dependent on other cognitive factors, like memory or more general cognitive abilities, we will test its relationship with the TAVEC and the MOCA results. We will also compare degree of dependence of the B4U task with that of the MINI-SEA on other cognitive factors.

In order to reduce the number of comparisons, composite scores were calculated with the tests measuring executive functions and memory, given the small size of our sample. The EF composite was calculated as the average of the z-scores of the semantic fluency, INECO total score and the 5 digits flexibility and inhibition. The memory composite instead, was calculated as the average of the z-scores of the TAVEC delayed free recall and recognition.

Finally, in order to test the ecological validity of the B4U task we will analyze its relationship with social integration in the community questionnaire and also with the experiential measures of caring others index or living with others index through correlational analyses. We will compare this with that found for traditional tests of social cognition like the MINI-SEA scores.

Results

Inter-rater reliability

Initially, several researchers from the Neuropsychology and ADL lab met and collectively established a scoring procedure by jointly watching and analyzing several videos. Once a consensus was reached, a comprehensive scoring protocol was developed, which served as a guide for individual evaluations of all 30 videos. Given the time constraints and the extensive duration required to thoroughly analyse each performance recording (approximately 45 minutes), the workload was distributed among the evaluators.

B4U data from twenty percent of the entire sample (i.e. six participants) were randomly selected to calculate the inter-rater reliability of the following indexes: necessary and extra questions, beginning state scores, and social traps.

Performance recordings were analyzed by four independent coders, previously trained with the coding scheme. Inter-rater reliability was assessed by intra-class correlation coefficients (ICC). ICC values below 0.5 are considered to indicate little reliability, between 0.5 and 0.75 indicates moderate reliability, between 0.75 and 0.9 indicates good reliability, and an ICC above 0.9 indicates almost perfect reliability (Koo & Li, 2016). The results indicated perfect inter-rater agreement on necessary questions (ICC = 0.99), on beginning state scores (ICC = 0.95) and extra questions (ICC = 0.90). However, there was no agreement between coders for social traps (ICC 0.19). After several sessions of discussion, we realized that different coders were given the maximum score to different behaviours (two were giving 3 points when participants showed joint attention with the evaluator before the first verbal cue, meanwhile the other two were given the 3 points only if the participants actively searched the hidden object). After the discussion sessions, the 4 coders redefined the scoring system (to give the 3 points if participants showed joint attention with the evaluator before the first verbal cue) and then obtained complete agreement for this index as well.

Testing the distribution normality of the social cognitive variables

We performed Shapiro-Wilk analysis and observed that all the variables of social cognition, those from the B4U task and those from the MINI-SEA did not follow a normal distribution with the exception of the BSC score. As a result, non-parametric statistics were used: Spearman correlations to analyze relationship between continuous variables and Mann-Whitney U test for dichotomic ones. All analyses were performed with the statistical program Jasp Version 0.9.1

Descriptive statistics about the sample characteristics: sociodemographic and social experience (living with and caring others) variables.

After excluding one participant who did not meet the inclusion criteria (see the methods section), we conducted the analysis with a sample of 29 participants. Of these, one participant was excluded from the analyses (including for the B4U task variables) due to technical problems occurred during the recording procedure, which did not allow us to properly evaluate his performance in the task. Nonetheless, the data from this participant were still included for the other analyses conducted. Similarly, another participant was excluded from the analyses involving the second part of the task, concretely from the

ones including the Total number of questions variable. The decision to exclude him was based on the observation that the participant did not ask any questions at all, and the evaluator forgot to ask him to repeat the instructions of the task; consequently, we couldn't be certain on whether this participant fully understood the task at hand. Nevertheless, his data were still included for the rest of the analyses derived from the first part of the B4U task (beginning scores and social traps). Finally, two participants that reported non-binary gender, were excluded from the analysis of the effect of gender on social cognition variables. The subjects' socio-demographical characteristics as well as social variables based on their experience living with others and caring others, are presented in Table 1.

As it can be observed, the group was formed by a quite homogeneous young and highly educated participants (almost all were university students and postgraduates), with almost equated number of male and female gender participants. In addition, there was high variability among participants in their prior/present experience living with others and on their experience caring others.

Table 1: Descriptive statistics of participants' socio-demographic variables and social caring and living with others

Characteristic	Category	N(%, Mean (sd;range))
Age	Mean (sd,range)	25 (3,73;19-35)
	19-27	n.26 (89,66%)
	28-35	n.3 (10,34%)
Gender	M	n. 13 (44,83%)
	F	n. 15 (51,72%)
	Other	n.2 (6,9%)
Educational level	Mean (sd,range)	16,79 (2,00; 12-22)
	<= 15	n. 12 (41,38%)
	>= 16	n. 17 (58,62%)
Employment	In employment	n. 12 (41,38%)
	Studying/not working	n. 17 (58,62%)
Living with others' index	Mean	1,23
	0	n. 2 (6,9%)
	1	n. 12 (41,38%)
	2	n. 14 (48,28%)
Caregiving index	Mean	0,73
	0	n. 15 (51,72%)
	1	n. 8 (27,59%)
	2	n. 6 (20,69%)

Descriptive statistics about the sample: neuropsychological and social cognition variables.

As it can be observed in Table 2, as a group, participants showed mean scores on the neuropsychological tests measuring global cognition, memory and executive functions within normal range according to standardized normative data derived from these tests. In addition, data about social cognition abilities obtained from the MINISEA regarding emotional recognition and ToM abilities were also considered within the normal range when compared to mean scores from a Spanish sample in a prior study (Quesque et al.,

2022). Regarding the social integration index of the Integration in the Community Questionnaire, we didn't find normative Spanish scores to compare with.

Table 2. Descriptive statistics about the sample neuropsychological and social cognition variables

	Neuropsychological tests	Mean (sd;range)
General Cognition	MOCA (N=29)	27,1 (2,63; 19-30)
Executive Functions	SEMANTIC FLUENCY Animals (N=29)	23,77 (3,15; 11-47)
	FIVE DIGIT Inhibition (N=29)	11,27 (6,9; -5-27)
	FIVE DIGIT Flexibility (N=29)	19,9 (12,14; -7-40)
	INECO FRONTAL SCREENING (N=29)	25,9 (1,54; 22-28,5)
Memory	TAVEC Long term free recall (N=29)	14,03 (3,5; 5-16)
	TAVEC recognition score (N=29)	99,8 (2,01; 81,8-100)
Social cognition	Social integration questionnaire (N=29)	10,20 (2,23; 7-12)
	MINI-SEA Total score (N=27)	34,96 (6,19; 10-40)
	MINI-SEA Faux Paux Subscore (N=27)	12,50 (2,56; 3,75-15)
	MINI-SEA Emotion Recognition Subscore (N=29)	29,72 (3,02; 24-35)

B4U scores and its relationship with socio-demographic characteristics

To examine the potential impact of gender on our social cognition variables, we conducted a Mann-Whitney analysis, excluding the two participants identified as non-binary. Contrary to our expectations however, none of the comparisons yielded statistically significant results. Concretely, the effect of gender on the BSC, on the social traps and on the total questions score were non-significant ($Z=0,89$; $p= 0.37$, $Z=-1,41$, $p=0.16$; and $Z=-0,39$, $p=0.7$, respectively). Consequently, we concluded that gender had no effect on performance in our task. To investigate the potential influence of gender on a more traditional social cognition test, we repeated the same analysis with the different sub-scores obtained from the MINI-SEA. In this case, the Faux Pas subcomponent (female's mean: 12.8 vs men's mean: 11.78) and the total score (women's mean: 25.8 vs men's mean: 24.5) showed statistical significance, $Z=2,13$, $p= 0.03$ and $F=2,24$, $p= 0.02$, respectively). The emotional recognition sub-score was far from being affected by gender ($Z= 0,32$, $p=0,74$). This suggests that women tend to achieve higher scores in ToM compared to men, at least when measured with traditional tests. Next, Spearman correlation analyses were conducted to examine the relationship between years of education and our indices from the Breakfast for You Task (BSC, social traps, and number of total questions). We found that none of these correlations were statistically significant (all $p > 0.05$). Similarly, when relating years of education with participants' scores on the MINI-SEA total, emotion recognition, and faux pas subcomponents, no significant correlations were observed (all $p > 0.05$). Therefore, we can conclude that neither our task nor the MINI-SEA scores seem to be influenced by years of education. As we will fully discuss later, this effect needs to be taken with caution, given the large homogeneity of our sample in this variable (almost all have university studies)

Convergent and divergent validity of the B4U task

To test for the convergent validity of our task, we conducted several correlational analyses to investigate the relationship between the different scores derived from the B4U and the indexes derived from the MINI-SEA test and the executive function composite.

As shown in Table 3., the results revealed significant moderate and positive correlations between the MINI-SEA total and Emotional recognition sub-scores with the BSC score from the B4U task. Importantly, this last correlation survived Benjamini-Hochberg correction. None of the other correlations reached significance.

Table 3. Convergent validity of the B4U task. Spearman Correlations between the variables derived from the B4U task and traditional performance -based measures of Social Cognition and EEFF composite

		B4U task variables		
		% BCS score	% Social	N° of Questions
		(n =28)	Traps score	(n=27)
			(n =28)	
MiniSea	Total Score	.411*	-.211	-.094
	Faux pas Subscore	.212	-.281	.129
	Emotion Recognition Subscore	.562**1	.139	.218
EEFF Composite		.223	.275	-.129

Furthermore, we aimed to assess the divergent validity of the B4U task variables by examining their correlations with other measures of global cognition or memory abilities: to determine if the variables derived from our social cognition task had low influence of other cognitive functions.

As we can see in Table 4, and consistent with our hypothesis, the results demonstrated null correlations between the cognitive variables derived from the MOCA or the Memory composite with none of the B4U variables. That pattern of results contrasted those derived from analysing the relationship of the MINI-SEA subcomponents and the MOCA and the memory composite; which revealed moderate positive correlations between the MINI-SEA emotion recognition subcomponent score with the MOCA and the memory composite, while the Faux Pas subcomponent did not significantly correlated neither with general cognition nor with memory composite. As a consequence these findings suggest that, in contrast to the B4U task, some aspects of the MINI-SEA could be influenced by other general cognitive processes apart from social cognition.

Table 4. Divergent validity: Spearman Correlations of the variables derived from the B4U task and traditional measures of Social Cognition with neuropsychological measures of general cognition and memory composite

	B4U task variables			Minisea	
	% BCS score (n =28)	% Social Traps score (n =28)	N° of Questions (n=27)	FP Subscore (n=29)	Emotion Recognition Subscore (n=29)
MOCA	.227	-.062	.121	.215	.321*
Memory composite	.117	.107	.139	.198	.411*

Ecological validity of the B4U task

Finally, to test for the ecological validity of our newly designed task (B4U task) it was necessary to study the correlations between the variables derived from the task and those obtained from more general measures that are thought to reflect the participant's social cognition in everyday life. We particularly examined the relationships between BSC score, social traps scores and number of total questions (observable on Table 5.) with global measures of social integration, caregiving experience, and living with others experience.

As it can be seen in Table 6., we found a moderate and statistically significant positive correlation between the social traps score and the caregiving experience index (although it didn't survived Benjamini-Hochberg correction later on). These results suggest that the ability to detect the other's perspective might be associated with increased caregiving experience. No other B4U scores showed any relationship with any social measure, indicating that such variables are not significantly related to the social factors taken into account.

Table 5. Descriptive statistics of participants' scores on the Breakfast for You Task

B4U Variables	Mean (sd; range)
Beginning comfort state (%)	74,49 (11,76; 50-96,15)
Social traps' score (%)	83,93 (16,3; 33,33-100)
Number of Total Questions	16,07 (10,44; 0-24)
Number of Necessary questions (Max. 12)	8,37 (4,69; 0-12)
Number of Secondary questions	6,9 (7; 0-22)

Table 6. Relationship between the variables derived from B4U task and global self-reported measures of Social integration, caregiving and living with others experience.

	B4U task variables		
	% BCS score (n =28)	% Social Traps score (n =28)	N° of Total Questions (n=27)
Social Integration	-0,057	0,060	-0,300
Caregiving experience score	0,225	0,427**	-0,246
Living with others score	0,172	0,034	-0,193

Significance levels: * = < .05; ** = < .01; 1= significant after Benjamini-Hochberg correction.

Discussion

The present study aimed to address the existing gap in the assessment of social cognitive abilities by designing a novel evaluation task that incorporated “first-person” everyday life scenarios with real interactions between the evaluated subject and the researcher. We designed this task upon the limitations of the traditional laboratory-based social cognition assessments highlighted in many of the extensive reviews find in the literature nowadays (Byom and Mutlu, 2013 and Osborne-Crowley 2020). In fact, it is commonly shared among researchers that static, not interactive and third-person protocols (which are still commonly used) do not completely capture the dynamic nature of real-world social interactions, lacking therefore of ecological validity.

In the Breakfast for You Task, we specifically included variables that we thought were investigating both the low-level, more automatic social cognition components, as well as the more higher-levels and complex ones (Mitchell and Phillip,2015).

Starting with the former ones, we decided to include the beginning state comfort scores because we have observed that, even if it is a component that has been receiving relatively growing interest during the last years, there is no actual research, to our knowledge, that directly test and compare it’s relationship with social cognition tests.

Prior studies have evaluated the motor aspects of perspective taking through the beginning state comfort effect, as a form of joint action procedure that is commonly observed among healthy young participants and in patients affected

by ASD by demonstrating a large performance variability depending on the severity of the diagnosis (Gonzalez et al, 2013; Studenka et al., 2017). However, in these studies researchers used sets of very few (from one to three) objects (Gonzalez et al., 2011, 2013 but see Cini et al., 2019 that included a set of 12 objects) with passive and artificial procedures, where each trial consisted on observing a passive movement of objects between the participants. By contrary, in our task BSC effects were observed embedded within the context of a daily living task, and using a large array of semantically related objects (12). We expected the beginning state comfort scores to be associated with low-level, more basic measures of social cognition because we consider processes such as joint attention or automatic processing of body positions and expressions more related to the processes involved in emotion recognition. As, expected, the data obtained from our analysis seem to support our idea, demonstrating a significant moderate correlation between the BSC score and the emotion recognition subscore obtained in the MINI-SEA test. The fact that such an effect survived Benjamini-Hochberg correction gave us more confidence about the results obtained. This link between the tendency to have BSC and better abilities to decode others expressive emotions, could be explained by the fact that social perception components related to the identification of emotionally salient information in the environment from multiple sensory systems (including the motor ones) are part of lower-levels processes that lay at the initial stages of social cognition (Mitchell & Phillips, 2015). Similarly, when passing an object to another person, it is probable that the individual take advantages of such basic and unconscious resources to automatically advantage the beginning state of the person in front of him/her.

On the contrary, our expectations regarding the other two B4U Task's variables (social traps and evoked questions) were not confirmed by the results obtained. In particular, we conceived such variables to be reflecting more higher-level social cognitive aspects related to ToM mechanisms, as a consequence we were expecting a significant positive correlation with the scores obtained from the executive functions composite score and those obtained in the Faux-Pas subscore of the MINI-SEA. The non-significant results might be explained by different causes. At first (which is also one of the biggest limitation of our study) we had a really small sample size from which we withdrew the results, as consequence we are missing sufficient statistical power to state whether the analyses gave rise to a false negative or if they are simply not the best and appropriate measures to assess the constructs of interest. Secondly, it might be possible that the results were the reflection of a problem in the way we were measuring these variables. Regarding the social traps, given the lack of initial agreement among the coders, we finally decided to attribute the maximum score (i.e. 3 points to each social trap) when the individuals simply demonstrated joint attention with the evaluator, that is the same score than for those who immediately started looking for a solution. It is possible that we are missing important information with this scoring system as the second type of behaviour might be related to a higher level of mentalizing capacities than the first. This is definitely something that might have not perfectly and accurately distinguished between lower and higher-level social cognitive components and that needs further investigation. Regarding the evoked questions another procedure artefact might had occurred. Based on the observation that a set of individuals completed the entire task without asking any questions at all, we wonder whether our instructions were sufficiently clear or led

to misinterpretation about the need to discover what the other person wanted for breakfast. Nevertheless, the instructions were the same for everybody and those lead most participants to start making questions to the evaluator. So, we think that the fact of actually making questions might be a signal of genuine social cognition abilities. Therefore, we believe that the most probable explanation for the lack of convergent validity with the MINI-SEA scores might come from the fact that our task is measuring different social cognitive aspects than the ones measured by the Faux pas and the emotional recognition tests included in that battery. Once completed the study we could have more information regarding this.

Another aim of this project was to develop a tool to measure social cognition but that reduced the influence of global cognitive or memory abilities. This was an important aim to accomplish in order to use the task, in the future, to assess social cognition in patients that suffer severe cognitive impairments. To do such a thing, first we designed a task that was built free of written information and that required the use and manipulation of common tools to perform a familiar and significant ADL task such as preparing a breakfast for someone. Later on, to test if we achieved this goal, we checked for the divergent validity by making correlation analyses between our B4U variables (beginning score, social traps' score and number of questions made) with the scores obtained in the TAVEC and in the MOCA tests. We particularly expected our ADL indexes not be correlated with the cognitive processes of interest, and consistent with our hypothesis, the results demonstrated null correlations. Because of this, we can easily make some clinical implications inferences by stating that, due to this lack of confusion with higher-level cognitive processes, our test could be easily extendable also to the social cognitive evaluations of those neuropathological populations of patients severely impaired in such aspects. By contrast the MINI-SEA, which is one of the most often used social cognitive tasks, did correlate with both the MOCA and TAVEC variables collected when measured within the same sample, thus suggesting that some aspects of the MINI-SEA could be influenced by other general cognitive processes apart from social cognition in a larger extent than our task.

Finally, based on extensive reviews (Achim et al., 2013; Osborne-Crowley, 2020;) which clearly highlighted the need of more ecologically and accurate social cognition assessment tests, we wanted to check for the ecological validity of our protocol by examining how it relates to several experiential factors thought to reflect the participant's social cognition in everyday life (care-giving index, living with others experience and/or global measures of social integration in the community). Because of this, we hypothesized that a better performance on the B4U task will be positively correlated with higher scores obtained in the Social Integration Questionnaire (reflecting a greater social integration). Moreover, we hypothesized our task to be positively influenced by factors such as the degree of caregiving experience and/or the experience of living with others. However, contrary to our expectations we did not completely satisfy the ecological validity construct. In fact, the Breakfast for You variables related to beginning state and number of questions made did not show any significant relationship with any social measures, indicating that such variables are not related to the social ecological factors taken into account. On the other hand, we did find a moderate and statistically significant positive correlation between the social traps score and the care-giving experience index, an effect pointing to the idea that prior experiences taking care of someone during our everyday life might increase our

ToM abilities, facilitating us in quickly grasping someone else's needs in social interactions.

Finally, we aimed at investigating how the several socio-demographic factors collected in the initial interview could affect our subjects' social cognitive abilities derived from the B4U task. Based on previous findings (Sommerlad et al., 2021), we expected to find better performance on social cognition measures from women compared to men. Additionally, we expected participants with higher levels of education to demonstrate superior performance. However, this, seems not to be the case: regarding the gender effects, none of the analyses resulted statistically significant, demonstrating that gender per se had no effects on the performance of the B4U task. We are thinking that this might be the result of the type of task we presented to the participants. It is commonly demonstrated that activities of daily living are most often accomplished by women compared to men (Sommerlad et al., 2021). However, the types of activities accomplished in everyday life situations vary in level of complexity, and contrary to the most complex ones such as for example preparing a whole dinner or hiring clothes, preparing a breakfast is one of the most common and easy instrumental ADL, as a consequence, we can imply that the non-gender difference observed, might be explained by the fact that both genders are equally capable and have the same prior experience in accomplishing the task at hand. This might constitute another potential advantage of the task, as can be administrated equally to men and women.

On the other hand, in favour of the common findings present in the scientific literature, gender seems to affect more traditional social cognition tests such as the MINI-SEA. It was in fact observed that in both the Faux Pas and total score sub-component, females performed significantly better than men, as normally observed (Christov-Moore et al., 2014). Moreover, no significant correlations were observed for any of the variables collected and the years of educations, contrary to what Sommerlad et al. (2021) demonstrated in their extensive review. Regarding this finding, we might say that the B4U task seems to have the potential to become a test non susceptible to educational levels, however we cannot still generalize such results because the sample demonstrated a level of homogeneity in educational levels (all participants were University students), and further investigations with different samples of different level of education would be required.

Limitations and future directions

Before concluding, it is mandatory to acknowledge that the small sample size obtained in this study, together with the fact that all but one of the significant moderated correlations found in this study did not survive the post-hoc Benjamini-Hochberg correction, limit the confidence on the conclusions we can raise from our work.

Given the time restrictions of the TFM, we couldn't complete the sample size obtained with the a-priori power analysis. The large number of within subjects measures and the long administration of the B4U task led to at least two hours sessions per participant. In addition, the coding of all neuropsychological tests and the analysis of each of the measures derived from the B4U task that cannot be automatized required long data decoding sessions (about 4 hours per participant). Therefore, it was impossible to complete the sample size.

Another drawback was the selection of some of the tests to measure social cognition or social integration. For example, I think that the inclusion of the

Community Integration Questionnaire was not the best choice to measure the ecological validity of the B4U task because it is true that it is thought to reflect the subjects everyday life in the community but only a few questions (6) ask for the actual social integration that we were investigating for, which might not be totally representing the construct of interest. For the future, we are thinking about re-evaluating the validity constructs behind such test while leaving open the option of switching it with more appropriate ones that have already demonstrated ecological validity on other social cognition tests (Milders, 2018).

To conclude, we have to say that the research presented in the present Master thesis project, although preliminary in nature, it has helped to initiate testing and answering the initial questions raised by the developers of the B4U task (Navarro-Egido et al., in preparation).

In general we can considered this work a pilot study, but the final aims of the biggest project, go far beyond those initial findings. For example, one way to continue this work is to obtain more fine-grained measures of both low-level and high-level indexes of social cognition components with the use of the information derived from the Tobii glasses system, which might help to quantify more deeply joint attention effects. For example, with this software we might obtain information of what, when and how participants fixate breakfast items related to their own preferences compared to objects related to the evaluators' ones. Similarly, the inclusion and comparison of groups differing in age or characteristics, might help to validate the appropriateness of the tool to identify both low-and high-level social cognition deficits in patients.

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Appendix

Part 1.

Informal pre-register of the Master's thesis project shared between me, the Professor and the research team on May 3rd 2023

INITIAL TFM PROPOSAL

VALENTINA ROSSI

TITLE: Study of the social cognition processes and its relationship with executive functions in within the context of a novel ecological task of activities of daily living (ADL)

INTRODUCTION: The idea behind this project relays on the fact that neuropsychological disorders and abnormal aging are shown to negatively impact social cognition; especially components of emotion regulation, empathy, moral reasoning, mentalizing and theory of mind (ToM) abilities.

Moreover it seems that, in the scientific literature, there is a lack of ecologically valid social cognition tasks aimed at measuring such impairments in this specific subgroup of patients. As a consequence, our research group is working on developing an ecological performance-based task to assess social cognition in patients and healthy controls; which can be placed into comparison to the standardized neuropsychological evaluations aimed at measuring executive functions and social cognition processes.

METHODS:

Participants: At the moment the experiment is being administered to two subgroups of people: elderly and young. Participants, in order to proceed with the task, are requested to be between age 18 and 80 and to possess a high level of the Spanish language comprehension. The recruitment is happening either through external contacts with clinicians from hospitals from the city of Granada associated to the project or through the Sona platform for students in psychology who received credits for participation, or... .

Procedure: The experiment consists in two phases: 1) a traditional neuropsychological evaluation and; 2) the administration of the performance-based social cognition task of an activity of daily living.

The neuropsychological evaluation begins by collecting the subjects' personal information (age, sex, education, profession, diagnosis, medications and taking care of someone information). Subsequently we administer the TAVEC Spanish version test (both short-term and long-term) in order to detect any memory impairments. Later on, the INECO FRONTAL SCREENING TEST (Spanish version) through which we observe any evident motor impairments such as inhibition, motor control and motor programming. We also administer the FIVE DIGIT TEST to measure attentional control and mental flexibility. And finally, the MONTREAL COGNITIVE ASSESSMENT (MOCA) to evaluate the participants' cognitive resources and functions. Those tests all fall under the standardized neuropsychological paper and pencil evaluations commonly administered to patients in clinical environments and are of particular interest for the executive functions domain. However, because we are also interested in the social cognition processes, we administer some tests aimed at measuring such aspects. In particular, the mini-social cognition & emotional assessment (MINI-SEA) to observe the possible social and emotional cognition impairments.

The CUESTIONARIO DE INTEGRACION EN LA COMUNIDAD in order to better understand the subject's social life and level of independence outside of the laboratory environment. And finally, some self-administered questionnaires aimed at detecting psychological traits of interests such as anxiety and depression.

The second part of the experiment consisted on the administration of the novel task designed by in our laboratory of Neuropsychology and ADL at the CIMCYC (Navarro-Egido et al., in preparation) to measure social cognition abilities and executive functions within the context of ADL. The task consists of asking participants to prepare a breakfast for the experimenter. With this task we aim at measuring several aspects relevant for social cognition such as theory of mind (i.e. perspective-taking or the ability to understand and adjust the own behaviour to others' perspective), but also the process of self perspective inhibition, a process typically associated to EEF.

At the beginning of the test, the participant is asked to help the experimenter to organize the table with the objects related to breakfast preparation. To do so, he/she were required to pass on to us a series of objects. In this part of the task, we can observe if the subjects are able to properly socially interact with a third person by observing at their movements to pass the object to another person (end/beginning states). It is also important to keep in mind that, approximately one week before the task, we ask the participants for their breakfast usual preferences and, when placing the objects on the table the day of the task, we insert their preferences (previously collected) as distractors and the breakfast we expect them to re-create is the opposite of what they usually like to eat. In any case, the subject is aware of the instructions and asked to rate him/herself on the task before and after. The main goal behind this second part of the experiment, is to observe for motor impairments, anosognosia aspects, executive functions deficits, social cognition and important aspects related to it such as mentalizing and ToM abilities while performing an activity to which the subjects is normally exposed to. However, in order to successfully pass the task, the participant is expected to overcome some social traps (of which he/she is not consciously aware) both related to executive functions or social cognition aspects. During the whole procedure the participants is recorded with an external camera and is asked to wear some eye-tracker glasses for scoring purposes.

ANALYSIS:

First we will analyse the interrater reliability of the social cognition task. To do so....

Second, we will provide descriptive statistics like mean and standard deviation about relevant socio-demographic variables of the sample like age, sex, years of education, or type of studies. Also given the relevance for our hypothesis we will describe the experience in caring, and in preparing meals to others.

Third, if the sample has sufficient numerosity and variability in the sociodemographic variables, we could do several group comparisons (i.e. one way ANOVAs) to test potential differences on the scores derived from the social cognition task depending on sex, and on high vs. low caring experience.

As the first aim of our study is to test the validity of this new tool to measure social cognition, we will perform several correlation analyses between the indexes derived from that task (and classical neuropsychological paper and pencil tests of social cognition and EEFF. If several socio-demographic variables strongly correlate with the scores derived from the ecological task, additional correlation analyses will be conducting controlling for these variables (partial correlations). Also if other cognitive processes such as EEFF or memory processes correlate with the social indexes from the task, additional partial correlations will be conducted between social indexes from the novel task and from the traditional tests controlling for these variables.

In particular, we have developed a scoring system for each of the observable components of interest from the social cognition task, such as the following:

- Beginning state comfort scoring: focus on the beginning -state postures undertaken during the first part of the task where the participant is required to pass every object to the experimenter This is interesting to observe because, when taking into account the other person with whom we interact when requested to pass on an object, we most of the time assume an uncomfortable posture at start (beginning state) to pass and re-orient the object in a comfortable way for the person we are interacting with (end-state). The scoring system is as follows: Two points with a complete rotation that lead to a "socially correct" beginning state posture at the end of the movement, 1 point with a partial rotation and 0 when the "socially correct" rotation/ beginning state-posture is not performed once the object has been passed on to the experimenter.

- Social traps scoring: We expose participants to a two social traps in order to get an index of social perception/theory of mind processes. In the first case, we purposely hide behind us two objects (napkins and extension cord) which result necessary at some specific moments and for the task at hand; however, because out of our sight we act like we have difficulties encountering them, and as a consequence, we expect the participants to get our needs/intentions and we expect them to help us by pointing at the objects we need (which again are out of our but not their sight). The scoring system to measure this component is as follows: 2 points when the participants are reactive enough and start helping like searching with us to respond correctly to our initial visual aim toward the object of interest, 1 point if the participants start searching but only after a verbal cue to our request (; and 0 points if the subjects does not start any searching behaviour, even after providing the visual and verbal cues.

- Evoked questions: As another measure of other self perspective (theory of mind) we counted the percentage of necessary questions evoked by participants in order to discover what sort of breakfast wanted the experimenter. As the participant is explicitly informed that the meal has to be prepared for a third person (the experimenter in this case) and he/she is informed that we are allowed to only respond YES or NO to the questions he/she wants to administer us. As a consequence, we expect the participants to ask questions about our preferences in order to make a personalized breakfast rather than the standardized meal that they usually make for themselves. Those questions in fact have the aim of delimitating the options of the ingredients present on the table based on the experimenter's likes. Therefore, when subjects success in making the target breakfast (by asking all the possible questions available), they will get a total amount of 6 points, and from there decreasing until 0 points when they do not ask for anything and prepare a breakfast without taking the experimenter's preferences into account.

- Secondary questions: with this category we intend the quantity and quality questions that could be asked by some participants while the breakfast is being made. Those are considered secondary because they are not necessary but they can provide details that we do not request from them. Considering the nonessential role that such questions have to the task itself, but because of the very detailed worrying interest of some of the subjects, we decided to further add a 0.5 point to the total performance score for every of those questions. The final idea is to draw a participant's profile by attributing a total score on such ADL task.

To do so we are thinking about utilizing a factor analysis in order to reduce the large number of variables that we are interested in into a common score which should represent the subject's social cognition and executive functions condition/profile.

HYPOTHESES:

We expect to find a pattern of large and significant correlations between the social cognition scores derived from our ecological task (beginning state comfort score, the evoked questions score and the social traps score) and the classical neuropsychological tests of social cognition such as the minisea and the social subscale of the PCRS. Also we expect

a significant correlation between the distractor score (ie. Self perspective inhibition) and traditional measures of EEF (five digits, ineco etc) .

For example, if a subject demonstrates a low score on the MINI-SEA, we would expect to see some social cognition deficits also in the novel ADL social cognition task. In such a way, if we will be able to find a correlation between the scores of the different subtests that we administer in the neuropsychological evaluation and the scores collected in the ADL task, we might be able to say that the task is ecologically valid in order to measure the interaction between the executive functions and social cognition aspects in situations that resemble what happens in the subjects' everyday life. Moreover, we expect to see some age differences in the participants' scores: the younger the participant, the higher the score and the more socially appropriate interactions will be observed in the task, while the older and the more neuropsychologically affected a patient is, the lower and the more deficits we would probably observe. However, it seems that older adults can particularly take advantage of their taking care of someone abilities when it gets to the ADL task, because the more time you spend at taking care of someone (such as a partner or a child) in your life the better you result at placing yourself in someone else's shoes. This is why we consider essential to ask and control for such aspect when we first meet the participant, in order to detect how much such experiences might affect his/her score in a positive or negative way.

Another goal of our experiment is to divide the neuropsychological tests into essential subcomponents that can easily be observed into the ADL task (as described in the procedure section). By detecting such aspects and comparing the participants' performance, we might be able to validate the task at hand by saying that we observed some type of correlation, possibly strong enough to be able to create a participant's profile with a defining score which might involve both of the aspects we are interested in: how executive functions and social cognition interacts or affect each other in healthy vs affected individuals in ADL tasks. Finally, we want to implement the social cognition aspects normally measured with some motor components in interactive tasks such as passing objects to another person. By observing participants' motor programming and the rotation that they perform on the objects during the interaction, we might not only be able to detect the percentages of healthy vs impaired subjects whose correctly perform those movements, but more interestingly, for which neuropsychological deficits such aspects are particularly impaired. In such a way, once again, we might be able to create standardized patients' profiles which might result useful even in the clinical or rehabilitation fields.

Part 2.
Ethics committee approval for the study

JUNTA DE ANDALUCÍA

CONSEJERÍA DE SALUD Y FAMILIAS

DICTAMEN ÚNICO EN LA COMUNIDAD AUTÓNOMA DE ANDALUCÍA

D/D^a: ANTONIO SALMERON GARCIA como secretario/a del CEIM/CEI Provincial de Granada

CERTIFICA

Que este Comité ha evaluado la propuesta del promotor/investigador (No hay promotor/a asociado/a) para realizar el estudio de investigación titulado:

TÍTULO DEL ESTUDIO: Estudio de los procesos de cognición social y funciones ejecutivas en el contexto de tareas cotidianas: Cambios debidos al envejecimiento (sano y alterado) y al daño cerebral
Protocolo, Versión: segunda
HIP, Versión: segunda
CI, Versión: segunda

Y que considera que:

Se cumplen los requisitos necesarios de idoneidad del protocolo en relación con los objetivos del estudio y se ajusta a los principios éticos aplicables a este tipo de estudios.

La capacidad del/de la investigador/a y los medios disponibles son apropiados para llevar a cabo el estudio.

Están justificados los riesgos y molestias previsibles para los participantes.

Que los aspectos económicos involucrados en el proyecto, no interfieren con respecto a los postulados éticos.

Y que este Comité considera, que dicho estudio puede ser realizado en los Centros de la Comunidad Autónoma de Andalucía que se relacionan, para lo cual corresponde a la Dirección del Centro correspondiente determinar si la capacidad y los medios disponibles son apropiados para llevar a cabo el estudio.

Lo que firmo en Granada a 28/07/2022



D/D^a. ANTONIO SALMERON GARCIA, como Secretario/a del CEIM/CEI Provincial de Granada

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CERTIFICA

Que este Comité ha ponderado y evaluado en sesión celebrada el 26/07/2022 y recogida en acta 7/22 la propuesta del/de la Promotor/a (No hay promotor/a asociado/a), para realizar el estudio de investigación titulado:

TÍTULO DEL ESTUDIO: Estudio de los procesos de cognición social y funciones ejecutivas en el contexto de tareas cotidianas: Cambios debidos al envejecimiento (sano y alterado) y al daño cerebral
 Protocolo, Versión: segunda
 HIP, Versión: segunda
 CI, Versión:

Que a dicha sesión asistieron los siguientes integrantes del Comité:

Presidente/a

D/D^a. AURORA BUENO CAVANILLAS

Vicepresidente/a

D/D^a. Paloma Muñoz de Rueda

Secretario/a

D/D^a. ANTONIO SALMERON GARCIA

Vocales

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- D/D^a. Juan Mozas Moreno
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- D/D^a. Encarnación Martínez García
- D/D^a. FRANCISCO LUIS MANZANO MANZANO
- D/D^a. MIGUEL LÓPEZ GUADALUPE
- D/D^a. MANUEL MARTIN DIAZ
- D/D^a. ANGEL COBOS VARGAS
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- D/D^a. RAFAEL MARIN JIMENEZ
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- D/D^a. MARÍA DOLORES GARCÍA VALVERDE
- D/D^a. ESTHER MOLINA RIVAS
- D/D^a. ANTONIO JUAN PÉREZ FERNÁNDEZ
- D/D^a. ANTONIO JIMENEZ PACHECO



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D/D^a. PATRICIA GALVEZ MARTIN

Que dicho Comité, está constituido y actua de acuerdo con la normativa vigente y las directrices de la Conferencia Internacional de Buena Práctica Clínica.

Lo que firmo en Granada a 28/07/2022.



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Part 3.

Community Integration Questionnaire (social Integration component)

Social Integration		
6. Who usually looks after your personal finances such as banking or paying bills?	Yourself alone (2) Yourself and someone else (1) Someone else (0)	
<i>Can you tell me approximately how many times a month you now usually participate in the following activities outside your home?</i>		
7. Shopping	5 or more (2) 1 – 4 times (1) Never (0)	
8. Leisure activities such as movies, sports, restaurants	5 or more (2) 1 – 4 times (1) Never (0)	
9. Visiting friends or relatives	5 or more (2) 1 – 4 times (1) Never (0)	

10. When you participate in leisure activities do you usually do this alone or with other?	mostly alone (0) mostly with friends who have head injuries (1) mostly with family members (1) mostly with friends who do not have head injuries (2) with a combination of family and friends (2)	
11. Do you have a best friend with whom you confide?	Yes (2) No (0)	
Social Integration Total Score	Add the above scores together	

Part 4.
The Meal Preference Questionnaire

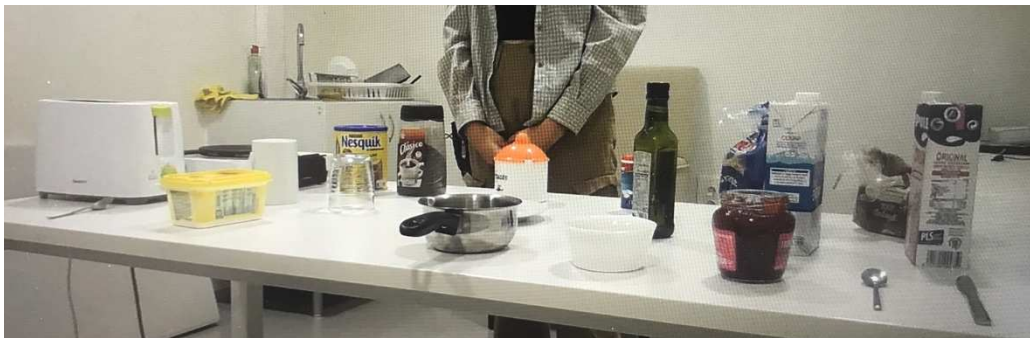
Indique el código que le han asignado	
Indique su edad	
Indica tu profesión	
Prefiere usted huevo frito o tortilla francesa	
¿Con qué frecuencia come usted tortilla francesa?	Menos de una vez por semana o nunca 1 o 2 días por semana 3 o 4 días por semana 5 o 6 días por semana Diariamente
¿Con qué frecuencia come usted huevo frito?	Menos de una vez por semana o nunca 1 o 2 días por semana 3 o 4 días por semana 5 o 6 días por semana Diariamente
Prefiere usted desayunar Café, Cacao o Té*	
¿Con qué frecuencia desayunas Café?	Menos de una vez por semana o nunca 1 o 2 días por semana 3 o 4 días por semana 5 o 6 días por semana Diariamente
¿Con qué frecuencia desayunas Cacao?*	Menos de una vez por semana o nunca 1 o 2 días por semana 3 o 4 días por semana 5 o 6 días por semana Diariamente
¿Con qué frecuencia desayunas Té?*	Menos de una vez por semana o nunca 1 o 2 días por semana 3 o 4 días por semana 5 o 6 días por semana Diariamente
¿Prefieres macarrones o spaghetti?	
¿Con qué frecuencia comes espagueti?	Menos de una vez por semana o nunca 1 o 2 días por semana 3 o 4 días por semana 5 o 6 días por semana Diariamente

¿Con qué frecuencia comes macarrones?	Menos de una vez por semana o nunca 1 o 2 días por semana 3 o 4 días por semana 5 o 6 días por semana Diariamente
¿Con qué tipo de salsa suele comer la pasta?	
¿Tiene usted alergia o intolerancia a la lactosa?*	
¿Prefieres leche entera, semidesnatada, desnatada o vegetal? *	
¿Tiene usted intolerancia o alergia al gluten?*	
¿Prefieres pan blanco o integral?*	
¿Prefieres desayunar tostada dulce o salada?*	
¿Con qué frecuencia desayunas tostada dulce?*	Menos de una vez por semana o nunca 1 o 2 días por semana 3 o 4 días por semana 5 o 6 días por semana Diariamente
¿Con qué frecuencia desayunas tostada salada?*	Menos de una vez por semana o nunca 1 o 2 días por semana 3 o 4 días por semana 5 o 6 días por semana Diariamente
¿De qué suele tomar la tostada?*	
Prefieres usar cepillo de dientes eléctrico o manual	
Prefieres azúcar o sacarina*	
Prefieres tomar el desayuno en taza o en vaso*	
Después de la ducha, ¿prefieres usar toalla o albornoz?	
Para lavarte las manos, ¿prefieres jabón de pastilla o líquido?	
Los días de lluvia, ¿prefieres paraguas o chubasquero?	
Hay algún ingrediente o material que no te guste nada y rechaces utilizar (ej; alguna fruta, tomate, el tacto de algún material, etc)*	
Tienes alergia o eres intolerante a algún otro ingrediente o material (ej. frutos secos, tomate, melocotón, algún producto de limpieza, etc)*	

Part 5.

Types of Objects present in the Breakfast for You Task (B4U)

OBJECTS	BEGINNING STATE	PRESENT ON THE TABLE
Milk type 1	Yes	Yes
Milk type 2	Yes	Yes
Coffee	Yes	Yes
Cocoa	Yes	Yes
Sugar	No	Yes
Sweetener	No	Yes
Cup	Yes	Yes
Glass	Yes	Yes
Bread type 1	No	Yes
Bread type 2	No	Yes
Olive oil	Yes	Yes
Butter	No	Yes
Tomato's sauce	No	Yes
Jelly	No	Yes
Small pot	Yes	Yes
Stove	No	Yes
Toaster	No	Yes
Teaspoon 1	Yes	Yes
Teaspoon 2	Yes	Yes
Knife	Yes	Yes
Fork	Yes	No
Scissors	Yes	No
Plate	No	Yes



Part 6.

Examples of beginning state comfort scores

- a) An example of successfully passing a knife with a full score (1) is when the object is passed to the experimenter with the handle



- b) An example of a partial score (0,5) when passing a knife is when the object is handed over to the experimenter with a partial rotation.



- c) An example of an incorrect score (0) when passing the small pot is when the participant keeps hold of the pot's handle and passes it to the experimenter in an uncomfortable/awkward manner, disregarding the experimenter's comfort and convenience.



Acknowledgements

Another wonderful journey has come to an end, and now is the time to spend few words to those who have been part of it and to those who accompanied me here, today.

First and foremost, I would like to extend my heartfelt thanks to María Jesús Funes Molina. With her knowledges and patience, she supported me every day, guiding me when I wasn't able to walk on my own. I will forever be grateful for the time, dedication and professionalism that you have shown me.

To Alba, Giorgia and María, I want to express my deepest appreciation. You have opened your arms to me even when it was not expected of you. Each one of you played an indispensable role in this thesis, and without your contribution, the creation of this work wouldn't have been possible. Despite the distance and varying time zones, I have always been able to count on you. I am honored to have had the opportunity to work with your ideas.

A special thanks goes to Prof. Mario Bonato, always available to open my eyes when I needed, and to encourage me in the moments when I doubted myself. This has made him a respected professor and a trusted advisor, always attentive to the needs of his students. It has been a pleasure to spend these five years with you, and I hope that our paths will cross again in the future.

I am grateful for every professor I met at the CIMCYC. You taught me to see psychology with different eyes, and you gave me a new passion: that of research. Once again you demonstrated that the choice I made is the right one, the one that makes me proud, satisfied, but above all, happy. I consider myself fortunate to have learned in such a stimulating environment like the one you have been able to create. Through your work and the smiles you brought to class every day, I have realized that there is nothing more satisfying and fulfilling than setting competition aside to work together to achieve a greater goal: a goal that surpasses individual accomplishments and strives for a better future. This is how I now see research.

Thanks to Daniela Paolieri who helped and guided me toward one of the best decision I have made in my life: being here today.

Juan Lupiáñez, it has been an honor to meet you. I feel deep esteem and admiration for your person. When I think of who and what I would like to become in the future, I think of your wisdom, your passion and your availability.

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