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Social information processing in young people with mild intellectual development disorder or borderline intellectual functioning: Relationship with real-world expression of executive function problems

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Abstract

The aim of this study was to explore the relationship between the three main executive functions (i.e., inhibition, working memory and flexibility) and three steps of social information processing model (SIP, Crick & Dodge, 1994). Participants were 42 young people (13 years old 5 months SD = 28 months) with mild intellectual development disorder (MIDD) or borderline intellectual functioning (BIF). The youths' relatives completed a questionnaire on the behavioral expression of executive functions (BRIEF), and each participant watched a video of an ecological social situation, then answered questions relating to the SIP model. The results offer interesting insights into the link between encoding and inhibition, and the influence of the type of intention attribution on inhibition and working memory.

Keywords: Social information processing; executive functions; Mild intellectual development disorder; Borderline intellectual functioning

1. Introduction

Social interactions have long been considered central and necessary to the development of human behavior (Wallon, 1982). As children develop, they have more and more opportunities for social interaction and become able to respond to increasingly complex social situations (Soto-Icaza et al., 2015). In this perspective, some authors consider that one of the major issues in social development lies in the ability to solve social problems (Dodge et al.,1986). More specifically, how a social situation is understood influences behavior and our subsequent social adaptation (Yeates et al., 2007). The social information processing model (Crick &

Dodge, 1994) illustrates the link that can exist between cognition and interpretation on the one hand, and the execution of a behavior during a social interaction on the other. This model describes six steps that take place successively with a cascade format, during the processing of social information : 1) encoding of elements both internal and external to the situation, 2) interpretation of the different elements, including the attribution of the intention according to the patterns stored in memory, 3) clarification of the behavioral goal, 4) the search for the most suitable social strategy in the repertoire of the memory, or the construction of new ones based on previous strategies, 5) generation of a behavioral response, evaluating the effectiveness in choosing this behavior based on previous experiences, and finally 6) the behavioral response.

1.1. Why study the link between executive functions and social information processing?

Executive functions (EF) are a set of high-level cognitive skills that are present in our everyday behaviors (Friedman & Miyake, 2017). They are notably mobilized in non-routine, or even conflictual situations (Diamond, 2016). Some authors have identified three main EFs that are distinct from each other, without however eliminating the presence of interdependence between them. Thus, three fundamental EFs have been modeled, showing their respective specificity and their common share: inhibition, updating (usually called "working memory") and flexibility (Miyake et al., 2000; Friedman & Miyake, 2017). Working memory is memory that can maintain a program to be executed by keeping intermediate information and results (Barrouillet & Camos, 2022). Inhibition is the executive function of blocking out information that is not relevant to the goal that needs to be achieved (Simpson & Riggs, 2007). Last, flexibility is the ability to adapt our thoughts and behaviors in response to changes in goals and environments (Blakey et al., 2016). Several studies show that these three executive functions are correlated with social skills in a population with or without neurodevelopmental disorder (e.g., Hutchison & al., 2020). In this perspective, the relationship between executive functions and social information processing has shown its importance in understanding typical and atypical functioning (Caporaso & al., 2021; Van Rest et al., 2019; Saad & Hassanein, 2020).

Thus, working memory could influence the encoding of elements of the situation and their use for later steps (see Caporaso & al., 2021). Inhibition could play a role which inhibits distractors and selects the most relevant components of the situation. Finally, flexibility could play a role which switches interpretations between two similar social situations when additional elements clarify a particular kind of intent.

1.2. Study of social information processing in mild intellectual developmental disorder – How do executive functions play a part?

Mild intellectual developmental disorder is characterized by a significant limitation in intellectual functioning and in the ability to adapt to daily life that appears during the developmental period (Schalock et al., 2011; DSM-V-TR, APA, 2022). Several studies mention particularities at the cognitive and executive level that can alter the social adaptation of people with intellectual disabilities, especially in new and complex situations. Indeed, there are difficulties in processing social information, especially due to difficulties in inhibiting thoughts or behaviors, flexibility, and retaining in memory some parts of information from the same situation (Büchel & Paour, 2005). Several authors have focused on social information processing in youth with intellectual disabilities with a particular interest in aggression (Verhoef et al., 2019 for a meta-analysis). However, there is ample evidence that shows that difficulties in understanding social situations in this population can lead to other adjustment difficulties that do not manifest as externalized reactions, but instead as feelings of isolation, loneliness, or rejection due to difficulty maintaining social interactions (Guralnick et al., 2006). Studies of social information processing in youth with intellectual disabilities show particularities at certain steps (Baurain & Nader-Grosbois, 2013; Van Nieuwenhuijzen et al., 2009; Van Nieuwenhuijzen, et al., 2004; Van Nieuwenhuijzen, et al., 2011). It is stated in the literature that young people with intellectual disabilities encode fewer relevant clues or are less accurate in their encoding (Gomez & hazeldine, 1996; Van Nieuwenhuijzen, et al., 2004). They also produce fewer assertive responses and show difficulty retaining items as the social problem becomes more complex (Van Nieuwenhuijzen et al., 2011). More recent studies have sought to identify the role of

executive functions in social information processing and show an influence of working memory and inhibition on the ability to process social information (Van Nieuwenhuijzen & Vriens, 2012; Van Rest, et al., 2019). To our knowledge, only these two studies relate to the link between executive functions and social information processing in youth with intellectual disabilities.

1.3. Need for an ecological approach to study the relationship between EF and SIP

The ecological approach considers that the environment and the person have a mutual relationship that conditions human development (Bronfenbrenner, 1979). Over the years, assessments and interventions related to executive functions have expanded. Insofar as they are described as mobilized for everyday behaviors, different research has insisted on the need for a more ecological and contextualized understanding of EFs (see Hoskyn et al., 2017). Some authors have thus considered EFs in relation to the everyday social experiences that the individual has in their environment (Guare, 2014; Hoskyn et al., 2017). For example, cognitive flexibility can be defined as a person's ability to change their perspective in a particular context and based on the means available in their environment (Wilson et al., 2018). Inhibition is thought of more as a socially adaptive behavior consisting of inhibiting behaviors that may have negative consequences (Gioia et al., 2015). Finally, working memory in its ecological dimension is considered as holding and manipulating information over multiple sequenced tasks (Gioia et al., 2015). Interest in EFs in relation to the social environment then becomes central to understanding and measuring EF as an adaptive construct. These notions are even more important to consider as the assessment of EFs in ecological contexts promotes the reproducibility of results (Guare, 2014), as well as the transfer of skills to real-life situations (Slomine et al., 2012). The literature even states that the assessment of EFs through standardized tests can pose problems of internal validity as the constraints of the standardization criteria are not particularly applicable to everyday life (Isquith et al., 2005). Other authors argue that only a minority of tests showing deficit scores represent a deficit in real life (Barkley, 2012). The theoretical validity of some neuropsychological tests measuring EFs is also questioned by some authors. Indeed, there are different standardized

neuropsychological tests for a single executive function. However, executive tests have not been developed to operationalize the theoretical concepts of EFs that define executive behavior (Lezak, 1995). This concern has increased the need to develop assessment methods of EF more ecologically-valid than traditional neurocognitive measures. For example, Behavioral Assessment of the Dysexecutive Syndrome-Children (BADS-C, see Fish & Wilson, 2021) and the Executive Function Challenge Task (Kenworthy et al., 2020) were developed in response to concerns about traditional performance-based measures. Another way of considering ecological behaviors has been thought through the realization of parental questionnaires on people's daily behaviors (Boateng et al., 2018). In this perspective, the BRIEF questionnaire (Gioia et al., 2014) has been widely used and shown to be very sensitive in reporting the behavioral repercussions of EFs in everyday life (Chevignard et al., 2012). More, this tool is widely used for the simple involvement of those around the person being assessed, since it can be filled in easily and conveniently (Hendrickson & McCrimmon, 2019).

The objective of our research was therefore to explore the relationship between real world expression of executive function problems and social information processing in young people with MIDD or BIF. To achieve this goal, a short video clip of a social situation was shown to the participants, and questions corresponding to three steps of SIP were asked then linked to the observations made in the EF questionnaire. As mentioned above, it is difficult to obtain a pure evaluation of each executive function. Indeed, all three executive functions share a common component (Friedman & Miyake, 2017). Therefore, even if the main EFs can influence each of the stages at different intensities, the hypotheses are formulated based on research about the link between EF and SIP, considering that certain EFs have a greater weight for certain stages (Gomez & Hazeldine, 1996; Van Nieuwenhuijzen et al., 2004). Inhibition and working memory are then expected to be linked to the encoding of situational elements. The attribution of intention in the scenario was also expected to influence working memory. Finally, it was hypothesized that a change in attribution of intention and response generation would have an influence on flexibility.

2. Method

2.1. Participants

A total of 42 children and adolescents (M = 13 years, 5 months SD = 28 months, with 23 boys and 19 girls) participated. The expected sample size was determined using G*power software with effect size of .20, error probability of 0;05, 70 power with two groups for analysis of variance and 3 predictor variables for multiple linear regression analysis. The effect size was planned to approach previous similar research exploring the variance of EFs in social problem solving (See Caporaso et al., 2021). Four participants were not included due to missing data (non-return of the parental questionnaire). All the participants had an intellectual quotient and an adaptative profile congruent with MIDD or BIF (DSM-V-TR, APA, 2022). Intellectual quotient was measured by the most recent French version of the Weschler test (WISC-V, 2016, WAIS-IV, 2011). The adaptative profile was obtained by the French version of Vineland-2 (Sparrow et al., 2015). All the cognitive and adaptive tests were carried out by the psychologists from these structures in the two years preceding the execution of this protocol. The diagnosis of mild intellectual development disorder was made by the psychiatrists of associations, based on cognitive and adaptive assessments. Due to the heterogeneity of the cognitive and adaptive profiles, it was not possible to retain an average of the global IQ and adaptation score for this population. Nevertheless, each participant had a cognitive score between 55 and 85, and an adaptive score between -4 and -2 standard deviations for each domain. It was intended to observe the particularities of SIP in a population with MIDD or BIF only. Participants with comorbid behavioral disorders, diagnosed psychiatric disorders or autism spectrum disorders were therefore not included in this study.

The origins of MIDD or BIF are not specifically known for most participants. For two youngsters in our sample, it was linked to a genetic disorder such as Down syndrome and X-Fragile.

All the participants are accompanied by a French medico-social structure for young people with mild intellectual developmental disorders., from the PEP18 association. They each benefit from multidisciplinary support combining day care and/or outpatient care.

2.2. Ethical concern

The ethics and research committee of the University of Tours approved this study (n° 2022-05-03). All the participants were recruited from the PEP18 association, which cares for members of all ages with disabilities in medico-social structures. An oral presentation of the research with a visual presentation was given to all the participants by firstly asking who would volunteer to participate in the study. For those participants who accepted, we sent an information letter (adapted according to the family's level of written language comprehension) and a consent form. Once the consent form was returned to the researcher, we made an appointment with the youth at their referral facility. At the same time, the questionnaires were given to the families, who then returned them to the researcher.

3. Measures

3.1. Social information processing steps

Social information processing was measured through the response of questions related to two videos showing ambiguous social problem situations. The questions are taken from standardized research relating to SIP in people with MIDD or behavior disorders (e.g., Van Rest et al., 2014; Verhoef et al., 2022). Pre-tests were conducted to test comprehension of the questions with three youths with mild intellectual developmental disabilities. The video material was designed based on real-life experiences of both children and adolescents (as other authors have also done such as Van Rest et al., 2014; Van Rest et al., 2019). The participants watched two 30-second videos with similar storylines. In these videos, two girls are discussing a film they are watching on a computer with each other. One of them says that her headset no longer works and asks her friend if she has one to lend her. Her friend lends her a headset that is identical to hers. At the end of the film, the girl who originally had the malfunctioning headset leaves with her headset friend's. In the second film, sound and visual elements irrelevant to the understanding of the social scenario were added. Of these, three visual

irrelevancies were added (a book on the table, a character who has changed clothes, and a little girl who passes briefly in front of the scene). Similarly, two irrelevant sound elements were added: a ringing telephone and laughter/chatter in the background for 1-2 seconds. On the other hand, in the second film, two elements relevant to understanding the scenario have been added, which could help reduce the ambiguity of the situation: a blue scrunchy is present on the headset, which is functional, and the little girl who has taken her friend's headset quickly puts the functional headset back in her bag, glancing at it when her friend looks away. Encoding was measured using the open-ended question "Can you tell me what is happening in this video?". For the rating of relevant and irrelevant elements, two young adults aged 28 and 29 (one man and one woman) were asked to quote the elements they felt were necessary to understand the social scenario. An inter-rater analysis using the Kappa (Landis & Koch, 1977) with a reliability of .77 revealed 5 relevant elements in the first scenario: 1) the discussion between two children, 2) the proposal to watch a film 3) the failure of the helmet 4) the loan of the helmet 5) one of the girls leaves with the wrong one (her friend's). Added to these 5 elements are the two relevant ones added in the second scenario: 6) the blue scrunchy and 7) the strong gaze. Using the same procedure, we ensured that the irrelevant elements acted as distractors by asking these two adults to name the irrelevant elements for understanding the social scenario. A Kappa score of 0.83 was obtained for the irrelevant elements in the second scenario. Interpretation was measured by the question, "Why did the girl on the right do that?". The answer to this question was noted in a binary manner. Indeed, either the participant attributed a rather involuntary intention (for example: "she did not do it on purpose since the headsets were similar") or voluntary (for example: "it was done on purpose because the headsets were not identical, there was a blue scrunchie on one"). For the response generation step, we asked, "How would you have reacted if you had been in the shoes of the girl on the left?". The responses were categorized into three possible responses: either the response is assertive/prosocial, aggressive/hostile, or passive/submissive. For the interpretation and response generation steps, we also measured whether there was a change in response

between the two scenarios, which we formulated in a binary way in our analyses as "yes" or "no".

3.1.1. Procedure

A single meeting in the psychologist's office was proposed to each participant. The psychologist sat next to the child, and a laptop computer was placed on the desk, facing the participant. It was specified that we would propose watching videos of an everyday situation and that we would solicit their opinions to answer questions relating to these videos. With this in mind, we felt that the young people had sufficient concentration and motivation to answer all the questions. The order of viewing was the same for all participants. First, they watched the video relating to the first scenario, then they watched the second video containing the irrelevant elements and the added relevant elements. After each video, participants responded orally to various questions relating to the stages of social information processing.

3.2. Real world executive problems

3.2.1. Parental questionnaire

The French parent version of the BRIEF (Gioia et al., 2014) was completed by the participants' legal representatives. If the legal representatives did not live with the youth daily (e.g., in the case of a foster care placement), the members of the foster family completed the questionnaire with the prior agreement of the legal representatives.

The completion of the questionnaire allowed us to obtain an independent score in flexibility, working memory and inhibition based on daily behaviors. For this scale, the family answered a set of questions relating to the child's daily behavior. For example, one of the questions for inhibition is: "Is impulsive", for flexibility: "Has difficulty adapting to new situations" or for working memory: "Has difficulty remembering things for a few minutes". A rating from 1 to 3 (for "never", "sometimes" and "often") gives a raw score for each executive function. This raw score is then converted into a standard score according to the person's age and sex. The

standard score obtained is between 20 and 80, where 50 is the average. More, a score of 65 or above is considered to have potential clinical significance.

4. Results

4.1. Overview of the analyses

The analysis of the results is based on the idea that the three main executive functions (inhibition, working memory, and flexibility) are correlated but can separate when measured with latent variables (See Friedman & Miyake, 2017). All statistical analyses were performed using the tenth version of the Statistica software.

The mean scores obtained for these three main scales and for the global executive composite (GEC), as well as the correlation matrix between these four measures, are presented in Table 1. The mean scores for each of the scales are above 65 for this population but lie around this significant value. These results are in line with those obtained by Shishido & al. (2020) showing the usefulness of measuring the behavioral repercussions of EF using the BRIEF-2 (Gioia et al., 2015) in a population with MIDD. Correlations between the three measures were significant at $p < 0.05$. In agreement with Friedman & Miyake (2017), the correlations are moderate, attesting to a link between these three functions, which can nevertheless be distinguished in a population with MIDD or BIF.

INSERT TABLE 1

The Kolmogorov-Smirnov test was used to test the normality of each of the distributions and showed no significant difference at p less than or equal to 0.05 with a normal distribution. The Chi-square values obtained for inhibition, flexibility, working memory and GEC respectively are: $\chi2 = 1.6$; $\chi2 = 0.30$; $\chi2 = 1.48$ and $\chi2 = 1.19$. The Grubbs test was therefore carried out for each of these variables to detect the potential presence of outliers. The test did not show the existence of outliers to be significant at p equal or less than 0.05. The Grubbs test values

obtained for inhibition, flexibility, working memory and GEC respectively are : G = 1,94 ; G = 2,11 ; G = 2,38 and G = 2,55. Finally, a repeated measures ANOVA revealed no significant effect of gender on EF (F (1 ; 40) = 1,66 ; p = 0,20), no effect of EF type on score (F (3 ; 120) = 1,59 : p = 0.19) and no interaction effect between gender and EF type (F (3 ; 120) = 0,28 ; p = 0.84).

4.2. Encoding and executive function

Step-by-step regression analyses were performed respectively for the encoding of relevant and irrelevant items, with measures of the executive function scores flexibility, working memory and inhibition as predictors. The GEC showed a significant correlation with encoded irrelevant items (see table 1). Nevertheless, it cannot be included in our regression model due to its strong correlation (higher than .7) with the individual inhibition and flexibility scales.

For the encoding of relevant items (see Table 2), the inhibition score is the best predictor of performance for the encoding of relevant items, with a score that alone explains around 28% of the variance in the encoding of relevant items. ($R^2 = 0.28$, $p < 0.05$). For the encoding of irrelevant items, the linear regression model failed to identify a score that could significantly predict performance in the encoding of irrelevant items (see table 3).

INSERT TABLE 2

INSERT TABLE 3

4.3. Interpretation, response generation and executive functions

Table 4 refers to the number and frequency of participants corresponding to the variable measured for the intention attribution and response generation steps.

INSERT TABLE 4

A one-way ANOVA was used to investigate the effect of the type of attribution to each of the two scenarios on the scores of the individual executive function scales and on the GEC score. For the first scenario, there was no significant effect at p equal to or less than .0.5 of the type of attribution on the scores corresponding to flexibility, working memory and inhibition; respectively: $F(1;40) = 0.28$, $\eta^2_p = 0.007$; $F(1;40) = 0.51$, $\eta^2_p = 0.013$; $F(1;40) = 0.55$, $\eta^2_p = 0.001$. Similarly, no effect of the type of attribution to the first scenario on the GEC score was found: $F(1,40) = 0.68$, $\eta^2_p = 0.017$. For the second scenario, there was no significant effect of the type of attribution on flexibility score ($F(1,40) = 1.27$, $p = 0.27$, $\eta^2_p = 0.031$). On the other hand, there was a significant effect of the type of attribution on: inhibition score ($F(1,40) = 4.79$, $p = 0.034$, $\eta^2_p = 0.11$), working memory score ($F(1,40) = 5.53$, $p = 0.024$, $\eta^2_p = 0.121$) and GEC score ($F(1,40) = 5.56$, $p = 0{,}024$, $\eta^2_p = 0.122$). Finally, there was no significant effect of a change of intention on the inhibition ($F(1,40) = 0.64$, $p = 0.43$, $\eta^2_p = 0.016$), working memory ($F(1,40) = 0.82$, $p = 0.37$, $\eta^2_p = 0.020$), flexibility ($F(1,40) = 0.20$, $p = 0.66$, $\eta^2_p = 0.005$) and GEC scores ($F(1,40) = 1.45$, $p = 0.24$, $\eta^2_p = 0.035$). For the response generation step, there was no significant effect of response change between the two scenarios on scores: inhibition ($F(1,40) = 0.001$, $\eta^2_p = 0.0020$, flexibility ($F(1,40) = 1.09$, $\eta^2_p = 0.026$), working memory ($F(1,40) = 2.232$, $\eta^2_p = 0.053$) and GEC ($F(1,40) = 1.56$, $\eta^2_p = 0.037$).

Discussion

The aim of this study was to explore the relationship between real world executive problems and the steps of social information processing in children and adolescents with MIDD or BIF. To answer this question, the relationship between the scores obtained in a parental questionnaire of young people in inhibition, working memory and flexibility respectively was studied, and was related to three main steps of the SIP. To our knowledge, this is the only study to assess this relationship in an ecological context correlating behavioral observations of main three FE with steps of SIP directly in a filmed everyday situation.

The first hypothesis concerned the existence of a link between a deficit in inhibition and the encoding of elements. Our hypothesis was validated since a link was found between a deficit in inhibition and a lower number of relevant items encoded in the social interaction situation. This result is consistent with previous research showing encoding difficulties in young people with MIDD or BIF (Gomez & Hazeldine, 1996; Van Nieuwenhuijzen et al., 2004). More specifically however, one of the major contributions of our study has been to clarify the role of inhibition in the encoding of relevant elements to the understanding of a daily social situation between peers. We also tested the relationship between inhibition deficits and the number of irrelevant elements. Contrary to our expectations, an ecologically assessed inhibition deficit in our study was not significantly related to greater encoding of irrelevant items. This result is more surprising given that inhibitory control is widely considered in the literature to be essential for inhibiting distractors or "missteps" (Diamond, 2020). Another executive process that we did not measure in our study could be implicated: the activation process. Activation is considered by some authors to be inextricable from inhibition during development (Houdé, 2007). It is defined as the ability to activate a cognitive strategy to perform a task (Gagné et al., 2009). Moreover, inefficiency in this process can lead to neglect of the goal of a task, even if that goal was originally understood (Nieuwenhuis et al., 2004). The objective in our study, and more broadly in any everyday social situation, would have been to select elements relevant to understanding the situation, in addition to inhibiting irrelevant elements of the situation. There may be a close involvement of inhibition and activation in the encoding stage of SIP. This may be why the measurement of inhibition was not sufficient to find significant effects in our study. Future studies could explore the influence of these two mechanisms in greater detail for the encoding step.

Our study also showed an effect of the type of attribution on inhibition for the second film. This effect may exist because we have previously seen that a deficit in inhibition is at the origin of a failure to encode relevant elements in MIDD or BIF individuals. Thus, the young people did not encode the additional elements to clarify the girl's intention in the second film (the blue scrunchie on the headset and the girl leaning towards the other girl to make sure that

she does not see her putting it in her bag). Under these conditions, they did not attribute a more voluntary intention in the second video than in the first. This result is consistent with the idea that the steps of social information processing occur successively and in a cascade format (Caporaso et al., 2021; Crick & Dodge, 1994). Thus, this study highlights the effect of causal attribution on behavioral repercussions of an inhibition deficit in young people with MIDD or BIF.

The second most important contribution concerns the relationship between working memory and SIP. It was hypothesized that encoding was linked to working memory, as well as with the attribution of the intention step. This hypothesis was based on the literature showing that a deficit in working memory leads to an encoding deficit (Barrouillet & Camos, 2001). This hypothesis is also linked to studies that have shown the important influence of working memory in the different steps of SIP (See Van Nieuwenhuijzen & Vriens, 2012; Van Rest, et al., 2019). Surprisingly, there was no significant link between a real-world problem in working memory and a failure to encode relevant elements of the situation. However, the attribution of intention step had an effect on the working memory score. Then, young people with a deficit in working memory do not therefore have difficulty encoding all the relevant elements of the social situation. However, they do not manage to "update" these elements in working memory (Miyake et al., 2000) to manipulate them efficiently during the intention attribution step.

Finally, it was expected respectively the effect of a change of intention and a change of response between scenarios on the existence of a flexibility deficit. This is an empirical speculation, since to our knowledge no study has found a link between flexibility and these SIP steps. However, it was hypothesized that being able to change one's interpretation or reaction according to elements in the environment might require cognitive flexibility (See Caporaso et al., 2021). Nevertheless, no significant effect of a change between the two scenarios was found in the intention attribution and response generation steps on the flexibility score. As described above, our hypothesizes were based on the idea that three main EFs can be distinguished even if they are correlated (Miyake et al., 2000). Under these conditions, we believe that a significant effect was not found because of an indirect influence of inhibition and working

memory. Young people with a flexibility deficit could simultaneously have both an inhibition and a working memory deficit as well. Under these conditions, as the elements of the situation may either not be encoded or not be manipulated for the intention attribution step, the attribution of the intention and the response generation would then be chosen arbitrarily or identically in each scenario, and independently of the answers to the previous steps of SIP. These findings are in line with more recent work by Friedman & Miyake (2017) who note that these executive functions can sometimes only be separated under certain specific conditions, when there are measured with latent variables.

Conclusion, limits, and perspectives

The results of this study allowed us to clarify the specificities of the relationship between EFs and SIP steps in youths with MIDD or BIF. These results offer interesting insights into the understanding of cognitive and social processes in young people with MIDD or BIF. It was observed that young people with a working memory deficit do not have encoding difficulties, but they are unable to update and manipulate the encoded information to offer an intention attribution adapted to the social situation. These observations lead us to consider that there are cognitive and social skills preserved in young people with MIDD or BIF, which are however not used, as an intellectual inefficiency (Lelièvre, 2005) rather than a deficit. Intellectual inefficiency underpins the idea of a functional inhibition of certain components, which can therefore be lifted under certain environmental conditions and brain plasticity. Applied to our study, the young people we met did not manifest a deficit in short-term memory. Nonetheless, the updating process is not functional and influences the causal interpretation in a case of everyday social situations. A first limitation concerns our sample size. It was envisaged that we would obtain similar effects to previous research studying the variance of FEs on problems similar to SIP (Caporaso et al., 2021). Nevertheless, the targeted sample size was not achieved due to the difficulty in recruiting our population linked to the exclusion of comorbidities with MIDD or BIF but also to the lack of questionnaire returns from families. Future studies should explore these effects with a larger sample.

A second limitation is that we had empirically assessed that flexibility could be related to a change in interpretation, but no effects were found to confirm this result. Future studies should investigate precisely how flexibility and executive functions in general develop with SIP in a typical population and in a population with MIDD or BIF. Several studies show, for example, that the development of inhibition increases from childhood to adolescence in a typical population (Cragg & Nation, 2008). However, to our knowledge, no study has investigated the development of this executive function in line with the development of social information processing and in people with MIDD or BIF. One perspective might be to compare the development of inhibition in social information processing in a typical population and in a population with MIDD or BIF. This future research could shed light on whether this is a deficit or a delay compared with typical development (Baurain & Nader-Grosbois, 2013) and thus suggest opportunities for social cognition support for young people in medical-social services. These suggestions provide opportunities to further explore this protocol in terms of a developmental effect, which is lacking and criticized by some authors (Orobio De Castro, 2004). These elements could make it possible to identify more precisely particular developmental sequences and target interventions at certain periods of development. Otherwise, it is important to consider the medium used to assess the SIP. Indeed, we chose to create a video scenario based on actual patient experiences, as other authors have done previously (Van Rest et al., 2014; Van Rest et al., 2019). This video medium has therefore never been used, even though the questions asked are based on standardization adapted to our population (Van Rest et al., 2014; Verhoef et al., 2022). The video medium seemed to us to be one of the most ecological solutions in our situation, thanks to its dynamic and lively aspect. Video support for studying SIP in a population with MIDD has already been shown to be effective in the literature (Van Nieuwenhuijzen et al., 2011; Van Nieuwenhuijzen, & Vriens, 2012). Nevertheless, it is possible to question certain aspects of our study. In our video, children and teenagers had to put themselves in the shoes of one of the characters and assign an intention. From this perspective, theory of mind (ToM), i.e., the ability to represent the mental states of others (Frith & Frith, 2005), could be involved in the ability to put oneself in

the place of the character in the scenario. However, the literature states that people with MIDD seem to have a delay in ToM (Fiasse & Nader-Grosbois, 2012). Further studies should check the influence of theory of mind in this protocol. A final point concerns the fact that the questions are asked by the experimenter. For response generation, the experimenter asks how the person would have reacted if they had been in the place of the character in the scenario. Participants may have voluntarily given a socially valued response since they are asked to name a behavior, as opposed to a real social situation where the behavior is produced. This situation could produce a social desirability bias (See Grimm, 2010). Future studies could take this potential bias into account in their analysis. One way of controlling for the influence of social desirability bias could be to use experimenters who have different levels of familiarity with the participant. Finally, encouraging research using virtual reality could further improve the ecological nature of SIP assessment and further reduce these biases (see Verhoef et al., 2022). This study could be adapted to this type of medium in the future.

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Declaration of interest statement

The authors report there are no competing interests to declare.

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Table 1

Means, standard deviations and correlations between BRIEF measures of executive function and items

	Mean score	Standard deviation	Inhibition	Working memory	Flexibility	GEC	RI	II
Inhibition	66.95	14.44	1.00					
Working memory	68.55	12.24	0.33*	1.00				
Flexibility	68.55	10.30	0.61*	0.48*	1.00			
GEC	70.29	11.08	0.74*	0.60*	0.76*	1.00		
RI	7.57	2.63	-0.52*	-0,24	-0.19	-0.29	1.00	
II	1.26	1.43	0.28	0.25	0.27	0.38*	-0.07	1.00

Note. GEC = global executive composite; RI = Relevant Items; II = Irrelevant Items.

* $p < .05$.

Table 2

Linear regression model on FE scores predicting performance on relevant items

Predictors of RI		Beta	R^2	*F change*	*p*
Step 1	flexibility	-0.19	0.036	1.48	0.23
Step 2	Flexibility	-0.09	0.066	1.37	0.26
	Working memory	-0.20			
Step 3	Flexibility	-0.07	0.279	4.91	0.005*
	Working memory	0.144			
	Inhibition	-0.58*			

Note. RI = Relevant Items.

* $p < .05$.

Table 3

Linear regression model on FE scores predicting performance on irrelevant items

Predictors of II		Beta	R^2	*F change*	*p*
Step 1	flexibility	0.268	0.072	3.10	0.08
Step 2	Flexibility	0.195	0.090	1.92	0.16
	Working memory	0.152			
Step 3	Flexibility	0.186	0.11	1.61	0.20
	Working memory	0.039			
	Inhibition	0.193			

Note. II = Irrelevant Items.

* $p < .05$.

Table 4

Number and frequency of participants for measured variables at intention attribution and response generation steps

Steps of SIP	Measured variables	number and frequency of participants
Interpretation	Involuntary response for the first scenario	N = 22 (52,3%)
	Voluntary response for the first scenario	N = 20 (47,6%)
	Involuntary response for the second scenario	N = 13 (31%)
	Voluntary response for the second scenario	N = 29 (69%)
	Same attribution of intention between the scenarios	N = 17 (40,5%)
Response generation	Same response selected between the scenarios	N = 28 (66.7%)