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## The relationship of executive functions with academic competency and social skills in adolescents with intellectual disability

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### Abstract

**Introduction:** Adolescence is characterised as a period of further development and maturation of higher executive functions (EF). It is well established that EF play an important role in social skills and academic competence of typically developing adolescents.

**Purpose:** The goal of this study was to examine the relationship between executive functions (EF) and academic competency and social skills in adolescents with a mild intellectual disability. In particular, we were interested to examine which EF have the greatest impact on social skills and academic competency.

**Methods:** EF were measured with the Behaviour Rating Inventory of Executive Functions (BRIEF), and social and academic competences were measured with the Social Skills Rating System (SSRS). The sample for this study consisted of 44 adolescents with mild intellectual disability aged 15-18 years old (mean age 16.7 years, SD- 1.4).

**Results:** The results of this study clearly pointed to the strong relationship between these constructs. Of all EF, planning had the strongest impact on academic success, and monitoring had the strongest impact on social skills.

**Conclusion:** EF are susceptible to training effects, we thus propose early interventions in these domains in order to increase the social and academic competence of persons with an intellectual disability.

**Key words:** executive functions, academic competency, social skills, adolescents, intellectual disability

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## 1. Introduction

Adolescence is usually defined as a transition phase between childhood and adulthood. It is a period characterised by significant hormonal changes, and changes in physical, cognitive and emotional domains (Crone & Dahl, 2012). Adolescence is also marked through a number of brain changes including structural changes as well as functional reorganisation in this period (Blakemore & Mills, 2014). This probably leads to qualitative changes in the nature of thinking, thus making adolescents more self-aware and self-reflective than pre-pubescent children (Blakemore & Choudhury, 2006).

Adolescence is also characterised as a period of further development and maturation of higher executive functions (EF), which develop parallel to prefrontal brain maturation (Selemon, 2013). EF can be defined as self-regulatory behaviours necessary for selecting and sustaining actions and guiding behaviours according to the rules (Mahone et al., 2002). EF are a complex cognitive construct encompassing several components including working memory, planning, and emotional control. The exact number of EF components is still a contentious issue amongst researchers. For example, one of the most influential models of EF posits that there are five EF components: behavioural inhibition, working memory, self-regulation, speech internalisation, and reconstitution (Barkley, 1997). Other researchers have also found a multi-component nature of EF although the number of components do not completely overlap with Barkley's model (Gioia et al., 2002). EF start to develop at preschool age (Garon et al., 2008; Mahone & Hoffman, 2007) and continue to develop into adolescence and adulthood (Anderson et al., 2001; Taylor et al., 2015). EF have been widely studied in children and adolescents with developmental and intellectual disabilities (Jansen et al., 2013; Kirk et al., 2015; Lanfranchi et al., 2010; Memisevic & Sinanovic, 2014; Pugliese et al., 2015; Rosenthal et al., 2013). These studies have found that individuals with an intellectual disability (ID) have marked deficits in EF skills such as working memory (Carretti et al., 2010) and flexibility (Petters-Scheffer et al., 2013).

Studies to date, involving typically developing adolescents, have shown the strong independent relationship between EF and academic achievement (Latzman et al., 2010). Besides being correlated

with academic outcomes, EF are also strongly related to social skills (McGee et al., 2008; Rinsky & Hinshaw, 2011). Persons with ID lag behind in academic achievement and also have more social skills deficits in comparison to their typically developing peers (Jenkinson, 1989; Smith & Matson, 2010). It has also been shown that persons with ID are less involved in social and academic activities and are often perceived as less mature and more aggressive (Margalit, 1989).

Thus, an important scientific question is whether there is a correlational link between social skills and academic competence. Researchers were interested in exploring the link between social skills and academic achievement, and most evidence pointed to an association between the two constructs, ranging from low to moderate correlation (Gresham, 1992). However, a causal link could not be established between the two constructs. Research has been scant in the field of ID regarding the relationship between EF, social skills and academic competence in adolescents. Thus, in this study, we set out to answer the following research questions:

1. What is the relationship between academic competence and social skills in adolescents with mild ID?
2. Which EF have a significant effect on social skills?
3. Which EF have a significant effect on academic competence?

There are several ways to measure the constructs of EF, social and academic competence. Most common ones are with rating scales and performance-based measures. Rating scales in general are very important in school assessments as they provide a valuable multidimensional assessment of children (Walthall et al., 2005). As the rating scales are a generally more ecologically valid tool for the assessment (Gioia & Isquith, 2004), in this study we opted for the use of rating scales as a way to assess EF and social/academic competence.

## 2. Method

### *Participants*

Teachers' reports on the EF, academic and social skills were collected. A total of eight teachers completed the questionnaires about the students with ID. The questionnaires were collected for 44 adolescents with mild ID, grades 1-4, aged 15-18 years (mean age 16.7, SD = 1.4 years). The diagnosis of mild ID

was made on the basis of their IQ scores (ranging from 50 to 70) and this information was found in the students' educational records. Also, all students didn't have any other sensory or neurological disorder recorded in their school documents. There were 38 boys and 6 girls in the sample. All adolescents attended the High School for Vocational Training in Sarajevo, Bosnia and Herzegovina.

#### *Procedure and instruments*

We selected a high school for vocational training of adolescents with intellectual disabilities in Sarajevo. We distributed a total of 60 consent forms for parents explaining to them goals of this study and received 44 signed forms. Teachers filled in the BRIEF and SSCR questionnaires only for those children for whom we had signed parental consent forms. In order to be selected as informants, teachers had to know the students for at least six months. The study protocol was approved by the ethical board of the Faculty of Educational Studies at the University of Sarajevo.

*Behavior Rating Inventory of Executive Function-BRIEF*, (Gioia et al., 2000) is a widely accepted, psychometrically sound and ecologically valid, scale for assessing EF from the perspective of teachers and parents. BRIEF consists of eight clinical scales: (1) Inhibit – measures impulsive control, that is to stop one's behaviour at the proper time; (2) Shift – measures the capacity to move freely from one situation to another and to solve problems flexibly; (3) Emotional Control – measures modulation of emotional responses; (4) Initiate – measures the ability to begin a task and generate ideas independently; (5) Working Memory – measures the capacity to hold information in the mind in order to complete a task; (6) Plan/Organise – measures the ability to anticipate future events, set goals and make an appropriate plan in order to solve the task; (7) Organisation of Materials – measures the ability to keep the workplace and play areas tidy; and (8) Monitor – measures the ability to assess performance during a task or after finishing a task in order to evaluate its effects. Teachers were required to answer the items regarding the behaviour of the children on a three-point scale (Never, Sometimes, Often). Lower scores mean

better performance. The internal consistency of the BRIEF in this study, Cronbach  $\alpha$  was 0.93.

*Social Skills Rating System- SSRS*, (Gresham & Elliott, 1990) is an instrument for the assessment of social skills. The instrument has been widely used in multiple research contexts - as a screening device and as a measure to assess treatment outcomes (Van der Oord et al., 2005). The instrument seems to have satisfactory psychometric properties (Merrell & Poppinga, 1994). SSRS has three versions, for teachers, parents, and self-reporting. The teacher version of the SSRS includes items that measure three domains: social skills, problem behaviours, and academic competency. On the social skills scale, teachers provided ratings of children's behaviours on a three-point rating scale ranging from 0 to 2. A rating of 0 means that the behaviour never occurs, 1 means the behaviour sometimes occurs and a rating of 2 means that the behaviour occurs very often. For the academic competency scale, teachers were required to rate the students in comparison with other students on a scale from 1 to 5 (1 represents performance of the student is in the lowest 10% while the 5 represents the performance of the student in the highest 10% range). In this study we only used measures of social skills (internal consistency Cronbach  $\alpha = .90$ ) and academic competency (internal consistency Cronbach  $\alpha = .92$ ).

#### *Statistical analysis*

We presented mean values and SD for all the predictor and outcome variables. In order to answer our first research question and to further explore the nature of our data, we calculated Pearson correlation coefficients for all predictor and outcome variables. For the second and third research question, we performed a stepwise regression with predictors being EF and outcome measures being social and academic competence. An alpha level of .05 was set for all statistical tests.

### **3. Results**

We first present descriptive data for both the outcome measures: academic and social skills and for predictors: Executive Functions measures. These data are presented in Table 1.

**Table 1**

*Descriptive data for social skills, academic competence, and executive functions*

<i>Outcome</i>	Mean	Std Dev	Min	Max
Social skills	90.73	11.40	63	116
Academic competence	92.89	13.28	61	115
<i>Predictors</i>				
Inhibit	14.41	3.74	10.00	25.00
Shifting	12.09	2.52	8.00	18.00
Emotional Control	14.77	3.16	10.00	22.00
Initiate	11.16	2.42	8.00	18.00
Working Memory	14.70	2.53	10.00	20.00
Planning	18.80	4.14	12.00	27.00
Organisation of Materials	7.64	1.66	6.00	11.00
Monitoring	12.45	2.86	8.00	19.00

We next present the results of correlation analysis between executive functions and social and academ-

ic competence (Table 2). Most of the correlations were statistically significant.

**Table 2**

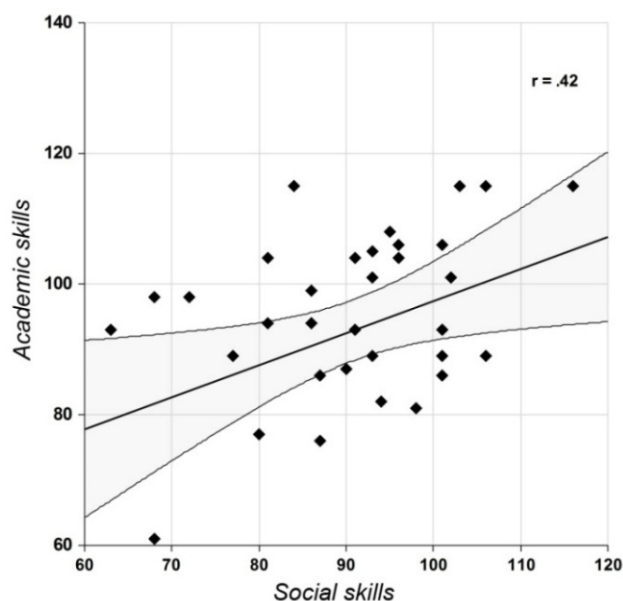
*Correlations between executive functions, social skills, and academic competence*

	<b>inhibit</b>	<b>shift</b>	<b>EC</b>	<b>initiate</b>	<b>WM</b>	<b>planning</b>	<b>org. mat.</b>	<b>monitoring</b>	<b>social skills</b>
social_skills	<b>-.28</b>	<b>-.36</b>	<b>-.54</b>	<b>-.45</b>	<b>-.52</b>	<b>-.57</b>	<b>-.13</b>	<b>-.64</b>	<b>-</b>
acad_skills	<b>-.36</b>	<b>-.41</b>	<b>-.49</b>	<b>-.35</b>	<b>-.62</b>	<b>-.63</b>	<b>-.02</b>	<b>-.41</b>	<b>.42</b>

Note. EC- emotional control; WM- working memory; org\_mat- organization of materials; Numbers in bold are significant at  $p < .05$  level.

As can be seen from Table 2, almost all correlations were significant at  $p < .05$  level. We were particularly interested in the relationship between academic and

social skills in adolescents with an intellectual disability. In Figure 1, we present the scatter plot of this relationship.



**Figure 1: Scatter plot of relationship between academic competence and social skills**

We then performed two backward stepwise regressions to predict social skills and academic competence from the set of eight EF predictors. It is important to note that although the predictor variables were correlated, there was no issue of multicollinearity. Predictors Initiate and Emotional control had

VIF of 5.3 and 5.2 respectively and all other predictors had VIF of less than 5. The first model predicted social skills and it was highly significant. However, the stepwise backward regression kept only one predictor of social skills, and that was *Monitoring*  $F(1, 42) = 28.5; p < .001$ . This is presented in Table 3.

**Table 3**

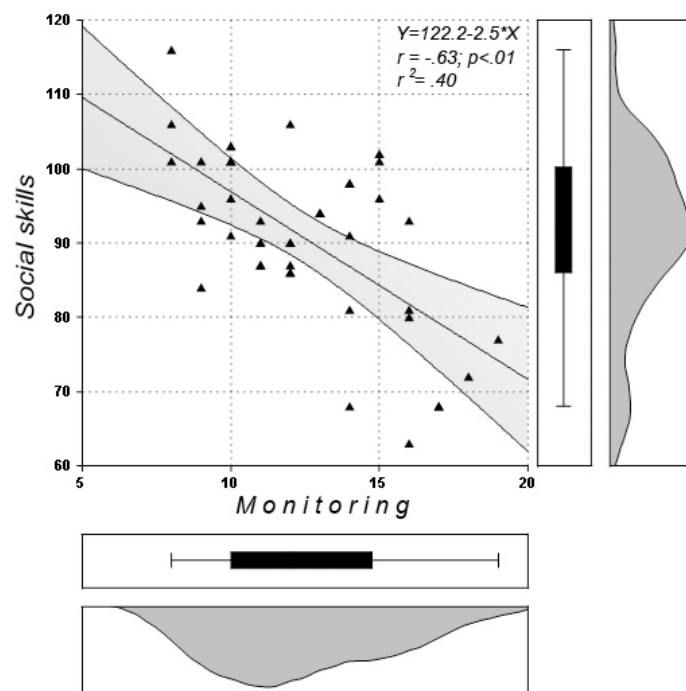
*Regression summary for social skills*

	$\beta^*$	Std.Err of $\beta^*$	b	Std.Err of b	t(42)	p
Intercept			122.2	6.05	20.2	.001
Monitoring	-0.64	0.12	-2.53	0.47	-5.34	.004

Note.  $R^2 = .40$ .

As there was only one significant predictor and in order to better illustrate this relationship, we next

present the scatter-plot of correlations between social skills and monitoring. This is presented in Figure 2.



**Figure 2: Scatter plot of relationship between monitoring and social skills**

In Table 4. is the summary of backward stepwise regression model for predicting academic success. Again, the model was highly significant and the only

significant predictor was *Planning*,  $F(1, 42) = 28.1; p < .001$ .

**Table 4**

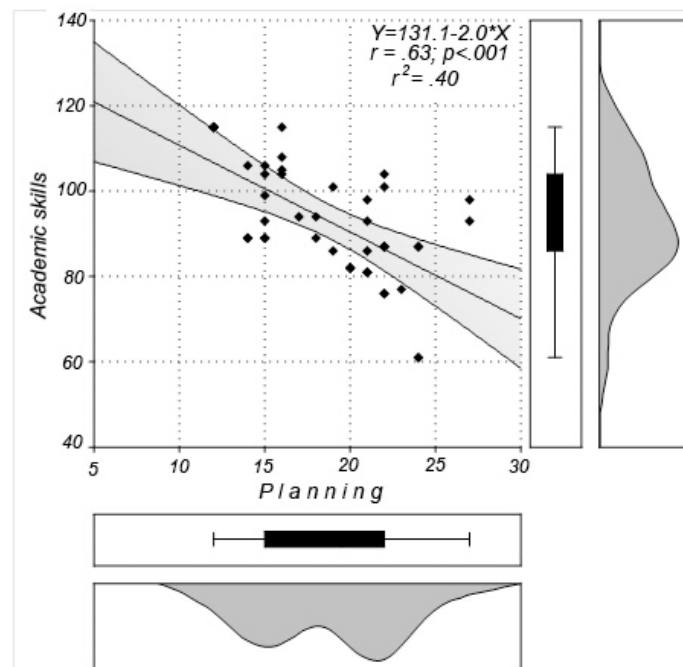
*Regression summary for academic competence*

	$\beta^*$	Std.Err of $\beta^*$	b	Std.Err of b	t(42)	p
Intercept			131.2	7.38	17.8	.001
Planning	-0.63	0.11	-2.03	0.38	-5.29	.001

Note.  $R^2 = .40$ .

Again, to better illustrate the relationship between Planning and Academic competence we present the

correlation scatter plot in Figure 3.



**Figure 3: Scatterplot of correlation between planning and academic competence**

#### 4. Discussion

The goal of this study was to examine the relationship between EF and social and academic competence in adolescents with a mild ID. Our first research question was to examine the relationship between social skills and academic competence. The results in this study confirmed previous findings of low to moderate correlation between these two constructs (Gresham, 1992). Although the causal link could not be established, explanations offered in the literature point both ways, from social skills deficits causing academic underachievement and vice versa. For example, in a study of third and fourth grade elementary school students, authors found that social skills were predictive of concurrent levels of academic achievement (Malecki & Elliot, 2002). If this causal link appears early at school age, it is of great importance to determine how this relationship unfolds further in the schooling process for the adolescents. However, it might be the case that this causal link is, in fact, inverse. Some authors refer to this as the “cycle of academic failure” (McIntosh, 2005). It means that students who experience academic difficulties or failure, engage in problem behaviours in order to avoid academic demands which in turn cause even greater academic problems. It is obvious that a potential causation link

can go both ways and although difficult to explain, the amount of joint variance is not that high. This means there are numerous other factors that can have an effect on both, social and academic competence. Next, we wanted to determine which EF are most correlated with social skills. We found that only monitoring had a statistically significant relationship with social skills. As the name implies, monitoring deals with a personal monitoring function, for example whether a child perceives what the effects of his/her behaviour are on others, or making careless mistakes or failing to check work. An example of a BRIEF item that measures Monitoring is “Does not realise that certain actions bother others”. The amount of shared variance between Monitoring and Social skills is 40%, indicating that the constructs are strongly related. This finding is not surprising given that self-monitoring is often viewed as a skill central to social interactions (Riggio & Friedman, 1982). Interventions in Monitoring skills can have a positive impact on social skills given the fact that monitoring skills are highly susceptible to training. Many studies to date have shown positive effects of monitoring training on social skills in children with developmental disabilities. For example, it has been shown that training in monitoring skills led to significant improvements in social skills in children with autism (Morrison et al., 2001). Techniques aimed at im-

proving self-monitoring have been especially successful in reducing behavioural problems (Bruhn et al., 2015). These strategies are especially relevant for students with an intellectual disability given their higher rates of emotional and behaviour problems than in typically developing children and adolescents (Dekker et al., 2002). Thus, it would be recommended for school authorities to have programmes in place for improving self-monitoring in children with an intellectual disability, even before or regardless if any social skills deficits are present in children.

Lastly, we examined the relationship between academic competence and EF. Of all EF, only planning had a significant effect on scores in academic competence. This domain encompasses the child's ability to set a goal and then determine the most effective method to attain this goal. As an example of a BRIEF item measuring this domain is: "Underestimates the time needed to finish tasks". Research to date has shown that children with an ID have marked difficulties in planning, even in comparison with children matched for mental age (Danielsson et al., 2012). Planning is a complex process, as the individual needs to plan actions, adopt a strategy to solve a problem, decide whether the action has resulted in a favourable result and modify the activities if the result is not achieved (Das, 1980). The importance of planning abilities cannot be overstated. The best early example illustrating the importance of planning comes from intelligence research in which planning was seen as a proxy for intelligence (Porteus, 1950). Another great researcher who considered planning to be the main executive function was Russian neuropsychologist Alexander Luria. He is famous for identifying three functional systems in the brain, one of which is the part responsible for planning and managing actions (Luria, 1976). In this study we found that planning and academic achievement shared about 40% of the common variance. Again, a large part remains unaccounted for but previous research has pointed to many factors contributing to academic success such as motivation, personality, selective attention, emotion regulation, etc. (Busato et al., 2000; Graziano et al., 2007; Memisevic et al., 2019). Our findings seem a little surprising as the only statistically significant EF predictor was planning and not working memory. A plethora of research exists pointing to the importance of working memory for academic achievement (Henry & Winfield, 2010; Schneider & Niklas,

2017; Titz & Karbach, 2014). However, in this study the impact of working memory was not statistically significant in the regression model.

Given the large share of common variance between planning and academic achievement it seems prudent to teach planning early in childhood to increase the odds of academic success. In this case, we hypothesise that the nature of the relationship goes from planning to academic achievement, although it is possible that academic success can also improve planning. There are not so many studies aimed at improving planning abilities in participants with intellectual disabilities. This is surprising given the importance of planning for everyday functioning. Planning interventions have been examined in other neurodevelopmental disorders such as in Attention Deficit Hyperactivity Disorder (ADHD). Research has found the benefits of treatments focused on planning abilities of adolescents with ADHD (Boyer et al., 2015; Bul et al., 2016). Given the strength of the evidence, we strongly suggest that programmes aimed at planning abilities be a part of every curriculum for students with an intellectual disability.

The main limitation in this study is the small sample size. The sample was barely acceptable for the regression analysis. Thus, we might have missed the predictors that have an important effect on both social and academic competence (such as working memory) but due to the small sample size they were not statistically significant. Also, we did not examine the effects of other, potentially important and confounding factors such as gender, parents' educational level, and socioeconomic status. One final limitation regards the objectivity of teachers as informants. In future studies it would be very useful to obtain data from parents as well, to complement the reports of the teachers.

## 5. Conclusions

There is a moderate, significant link between academic competence and social skills in adolescents with a mild intellectual disability. Monitoring was the only executive function that was significantly correlated with social skills. Likewise, planning was the only executive function that was significantly related to academic competence. As both these constructs, monitoring and planning, are susceptible to teaching and training effects, we propose early interventions in these domains in order to increase social

skills and academic competence of persons with an intellectual disability.

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### Conflicts of interest

The authors declare no conflict of interests.

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