

A Generalized Linear Model of Some Executive Functions on Cognitive and Affective Empathy of Students with Autism Spectrum Disorder (ASD)

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Abstract

Autistic spectrum disorder (ASD) is a neurodevelopmental disorder that affects the learner in school and their general functioning in school. Over time, efforts to address these challenges have been made, but attention to empathy has scarcely been paid. It is important that these students are integrated appropriately into the social environment. This study sought to examine how executive functions can be modelled to explain the variances in ASD students' empathy. A cross-sectional survey design was used with a total of 245 students. The Reniers et al. (2011) scale on cognitive and affective empathy (CAES) and the Behavioral Rating Inventory of Executive Functions (BRIEF), developed by Gioia et al. (2000), were the major instruments used for data collection. The data collected were analyzed using regression techniques, and the findings revealed that executive functions: cognitive flexibility, working memory, planning, emotional control, and inhibitor control relatively and compositely contribute to explaining the variances in affective and cognitive empathy among students with ASD. The study provided valuable insights into the experiences of students with ASD, and it recommends interventions aimed at supporting emotional regulation as a potential means of enhancing social tolerance and empathetic abilities, thereby facilitating better social functioning.

Keywords: Autism Spectrum Disorder (ASD), empathy, executive functions, linear models.

Introductions

Emotions play a huge role in most areas of human experience and the manner in which people manage them can impact the overall well-being of the individual. People need love and care of those who surround them in the social life because such relationship contribute to emotional support and well-being. In the African continent, one will find a powerful social cohesion whereby, individuals would expect several of their friends and acquaintances to assist them and show compassion particularly when they go through a difficult time. The concept of empathy, focusing on understanding and relating to others' emotions has been a subject of research for some time now and has been examined independently well. One perspective sees empathy as an idea (according to Zaki & Ochsner in 2012). Although there have been studies conducted on this topic for the exploration of how empathy connects with cognitive and emotional aspects along with variables like executive functions, which remains relatively unexplored. While this study relies on person-first language, which is currently standard in academia, as much people with ASD now prefer identity-first language as a way to assert autism as an inseparable component of personality.

Empathy is widely recognized as a multifaceted construct composed of two primary components: affective and cognitive empathy. Affective empathy involves sharing and responding to the emotions of others (Jones et al., 2010), while cognitive

empathy refers to the ability to understand another person's thoughts and feelings in order to comprehend their perspective (Baron-Cohen, 2011; Decety & Holvoet, 2021). These aspects play a role, in how individuals connect and relate to one another (Dziobek et al., 2011). Understanding empathy involves focusing on how one can understand the thoughts intentions of others. Various researchers have explored this topic (Shimai Tsoory et al., 2002/2009; Shimai Tsoory, 2011; Zaki & Ochsner 2012; Chakrabarti & Baron Cohen, 2006; Singer & Lamm 2009). The experience and expression of empathy in adolescents with ASD have been widely discussed in research, with early studies often characterizing these individuals as having challenges in understanding or responding to the mental states of others (Jones et al., 2010; Gaigg, 2012; Schwenck et al., 2012; Sucksmith et al., 2013). In particular, Fletcher-Watson et al. (2014) noted that individuals with ASD are not always the same when it comes to their associations with other people, including the translation of social-emotional signals. Nevertheless, modern studies are emphasizing more and more that these differences can be explained by diverse neurodiversity in the processing of emotions and social information, and do not indicate empathy deficits as such (Milton, 2012; Crompton et al., 2020). The idea of the lack of empathy in adolescents with ASD is being revisited seriously in favor of theories like the double problem which describes that a breakdown

often happens as a result of reciprocally misunderstandings between neurotypical and individuals with ASD (Milton, 2012). Rather than pathologizing these differences, it is important to explore the specific cognitive processes that may shape how empathy is expressed. While earlier studies (Ponnet et al., 2004; Dziobek et al., 2008) noted that cognitive empathy, the ability to understand another's mental state can present differently in adolescents with ASD, fewer studies have examined how executive functions may mediate this relationship. This study aims to contribute to this emerging area by investigating the links between executive functioning and both cognitive and affective empathy in students with ASD.

Executive functions refer to a set of high-level cognitive processes that enable individuals to regulate their behavior, manage their thoughts and emotions, and achieve goal-directed outcomes. These functions include abilities such as working memory, cognitive flexibility, inhibitory control, emotional regulation, and planning. According to Pellicano (2013), executive functions are cognitive-based abilities that involve flexibility in decisions, goal-oriented behavior, working memory, planning for the future, problem solving, and communication effectiveness. Although there are a lot of uncertainties surrounding the nature of executive functions (Best et al., 2011), they are an interrelated set of constructs that help individuals plan, shift decisions, and control themselves in order to have a purposeful life (Munro et al., 2017). What helps an individual plan his daily schedule, think about how to solve a particular problem, and make meaningful decisions is what is termed an executive function (Brock et al., 2009). Executive functions have different components that are sometimes perceived to be distinct but are very related (Zelazo & Carlson, 2012).

These various components regulate the activities and behavior of individuals in an adaptive manner. There are various classifications of executive functions by different authors. Some classifications include cognitive flexibility, working memory, planning, and inhibition (Alejandra et al., 2019; Anderson, 2002). The working memory used in this study is the memory that stores information on a short-term basis. This implies that it can be susceptible to distractions and sensitive to environmental activities because it works simultaneously with other activities in the environment (Loftus & Loftus, 2019; Baddeley, 2000). The function of the working memory is to receive information that is vital at any time, retain it, and manipulate it to produce a result for an identified problem. According to Anderson and Reidy (2012), the working memory is the part of the brain that destabilizes existing information to update it and utilize it in exhibiting behavioral patterns. It helps in solving mathematical puzzles, reasoning abilities, and language understanding. (Ferbinteanu, 2018). Highlighting the various coordinated modules of the working memory, Alexander and Stuss (2000) pointed out clearly that the working memory carries out three modules, which are the language loop, the visual-spatial information loop, and the central executive loop. Each of these helps the working memory to perform and monitor changes in the individual that

culminate in problem solving (Wilhelm et al., 2013; Baddeley, 2000; Engle, 2002).

Secondly, inhibition, otherwise called behavioral control, is the ability to control impulsive behavior that is dominant in an individual. The behavioral traits that are dominant are often considered irrelevant; thus, there is a need to suppress them and focus on the most important information. It is the ability to filter out behavioral traits that are not appropriate and thoughtful for a particular course of action. That is, it rests on the ability of the person to make a choice during rising tendencies. Simply put, it is the disposition to think before doing something. However, this executive function has two components: behavioral inhibition and cognitive inhibition. It is cognitive inhibition that is associated with executive functions such as planning, analyzing a situation, and then choosing the right response to a stimulus (Anderson, 2002). It can be deduced that inhibition control is concerned with the ability of an individual to control one's actions, thoughts, and emotions in order to override either internal or external factors that trigger a behavior and instead choose to do what is right and appropriate (Diamond, 2013).

The third executive function is cognitive flexibility. Cognitive flexibility refers to the ability of an individual to allow adjustment to the thought process and switch between tasks. It is the ability to modify actions and strategies and allow a variety of alternatives to cluster in order to plan meaningfully. It is the ability to approach a stimulus from different points of view and allow the mind to rigorously go through various alternatives rather than holding to a particular strategy. (Anderson, 2002; Cragg & Chevalier, 2012). This is because, in most cases, the solution to a problem does not require just one method but a broader perspective to bring a solution to the problem. Planning involves a series of activities with the intention of executing a task in the future in order to achieve a particular objective. In the context of this study, planning is concerned with the ability to resolve problems. It is dependent on the functionality of the working memory and central executive functionality (Baddeley, 2000). It goes with other activities such as the coordination of information based on the objectives that have been set, the methods to follow, and the activities that must be carried out to achieve the objectives. Self-regulation is a critical factor frequently considered by teachers to assess how the student is able to regulate himself or herself in the absence of the teacher and parents in order to develop affective characteristics that will promote social relationships. As far as executive functions are concerned, self-regulation can be reflected in areas such as 'proper pacing and planning of tasks under certain time limitations' (McCloskey, 2015). Studies reveal that executive functions are traditionally linked to the prefrontal cortex (Becker et al., 2014; Moriguchi & Hiraki, 2013), but recently, it has also been noted by other studies that other parts of the brain, such as the parietal lobes, cerebellum, and temporal lobes, are part of the executive function (Munro et al., 2017).

Thus, empathy, both cognitive (understanding another's perspective) and affective (feeling another's emotions), is believed to require several underlying cognitive processes, such as inhibitory control, perspective-taking, and emotional regulation. These are key components of executive functioning (Smith et al., 2022). For instance, the ability to suppress one's own immediate reactions in order to consider someone else's point of view draws on inhibitory control and cognitive flexibility. However, the relationship between executive functions and empathy, particularly among individuals with ASD, remains theoretically and empirically complex (Powell et al., 2022). There is limited clarity regarding how these constructs interact, and this gap is especially pronounced in African contexts, where few empirical studies have explored this association. Therefore, investigating this link can provide new insights into cognitive and emotional development in ASD from a culturally relevant perspective.

Previously, extensive studies have been conducted on the relationship between executive functions and behavioural outcomes (Duncan et al., 2017), visual motor skills (Becker et al., 2014), reading ability (García-Madruga et al., 2014), delinquent behaviour (Munro et al., 2017), and academic achievement (Cragg et al., 2017). The results of studies as it concerns empathy are heterogeneous, with several studies that are carried out using executive functions, focusing on only some aspects of cognitive functions. In a study by Cid-Sillero, Santiago-Ramajo, and Martín-Lobo (2018) result showed that a significant relationship exists between executive functions and empathy. This study did not incorporate other aspects of executive functions such as working memory, planning, self-regulation, and purposeful behaviour. The study was also not focused on these special students, which is the interest of this study. Riccardo-Williams et al. (2023), study looked rather at the attachment complexities of adolescents and not empathy among the adolescents who were not defined as autistic. Mazza et al. (2014), showed that they lack the capacity to interpret people's emotions as well as their mental states. The study was more of a quasi-experimental study that involved a small number of respondents, whose findings may not permit generalizability to other areas. In a similar study by Nicholas et al. (2021), found to share divergent relationships with self-reported emotion dysregulation. Trait cognitive and affective empathy were differentially related to both task metrics. Even though this study is meaningful, it fails to provide us with adequate information as to the role of executive function but rather explains cognitive and affective empathy using emotion differentials. Other studies have also provided that executive functions may explain the variabilities in empathy that are exhibited by students because of a seeming close relationship (Iacono et al., 2015; Lidia & Ryszard, 2017).

Although there are many studies that have been carried out using executive functions in relation to variables, as shown in reviews. Traditionally, research on executive functions has focused on areas of cognitive demand and less on affective demand. Most of the studies either relate executive functions to other variables like self-regulation (Brock et al., 2009; Lan

et al., 2011) or academic performance (Best et al., 2011). The close study of Mazza et al. (2014) who will have shared similar attributes with this study, was only interested in describing the characteristics of these sets of students and how they can be identified. It is only recently that executive functions have been associated with variables like empathy and self-regulation. In contrast, most studies on empathy have been linked to psychosocial variables to make predictions regarding the explanation of certain behaviours and affective states of learners (Zhou et al., 2012). However, contrary to what has been observed in adolescents with ASD, the study did not find any relationship between inhibitory control, working memory, and empathy scores. Similarly, such studies are conducted in Europe, and a few are carried out in Africa and Nigeria, where this study is carried out. Yet these students exist in their numbers in this setting. It is not to the knowledge of the researchers if previous studies exist that have examined executive functions with variables such as cognitive flexibility, working memory, planning, emotional control and inhibition control on cognitive and affective empathy among adolescents with autism spectrum disorder (ASD). The purpose of this study, therefore, is to examine:

- The relative effect of cognitive flexibility on cognitive and affective empathy among adolescents with autistic spectrum disorder.
- The relative effect of working memory on cognitive and affective empathy among adolescents with autistic spectrum disorder.
- The relative effect of planning for the future on cognitive and affective empathy among adolescents with autistic spectrum disorder.
- The relative effect of inhibition control on cognitive and affective empathy among adolescents with autistic spectrum disorder.
- The relative effect of emotional control on cognitive and affective empathy among adolescents with autistic spectrum disorder.
- The composite effect of executive function on cognitive and affective empathy among adolescents with autistic spectrum disorder.

The present study of executive functions in relation to cognitive and affective empathy among adolescents with ASD is very important in a world where compassion and social skills are emphasised to reconstruct our rehabilitation paradigm for improved empathy capacities.

Methodology

The study was a quantitative cross-sectional study involving participants with autism spectrum disorder (ASD), aged 8 to 18 years, in three geopolitical zones comprising twelve states in Nigeria. Autistic spectrum disorder participants were selected by the Zonal Reference Regional Centre, Rivers, Anambra, and Ibadan States, all in Nigeria. The diagnosis for ASD was done by experienced clinicians (developmental paediatrician, child psychiatrist, psychologist) and special education professors who have spent at least 15 years in their

profession using the new criteria of the DSM-5 (American Psychiatric Association, 2013). According to APA (2013), the criteria for a child to be considered autistic is that such a child must have defects in social communication and interaction in three areas: deficiency in social-emotional reciprocity, deficit in developing and maintaining relationships: restricted, repetitive patterns of behaviour, interest or activities in motor movement, and inflexible adherence to sameness or ritualised patterns of verbal or nonverbal behaviour, among others. The Autism Diagnostic Observation Schedule, Second Edition (ADOS-2) as developed by Lord et al. (2012) was used in the diagnosis of adolescents with this condition. Thus, a total of 245 adolescents with ASD were selected using purposive sampling techniques with the help of their teachers. The demographic characteristics of the respondents are given as follows: males (n = 88, 54.50%), female respondents (n = 157, 45.50%). Adolescents with ASD below 8 years old (n = 23, 9.38%) 8–11 years (n = 107, 43.67%) 12–18 years (n = 115, 46.94%).

Measures

Cognitive and Affective Empathy Scale

The Reniers et al. (2011) scale on cognitive and affective empathy (CAES) was used for this study. The scale is a 31-item self-report questionnaire assessing respondents' capacity to feel the pains of others as well as look deeply to understand what others feel. It is divided into five subscales that track the two dimensions of empathy (cognitive and affective). The cognitive empathy dimension assesses one's propensity to infer the thoughts and state of another person to understand their state. It has items like, 'I usually try to put myself in another's shoes when I am angry with them'. 'I can sense if I am intruding, even if the other person does not tell me.'. The dimension of empathy includes questions that evaluate how well individuals can empathize with others emotions imagining themselves in those situations (such, as "Being, around a group makes me happy but seeing others sad affects me"; "When a friend seems upset it impacts me deeply"). Respondents express their opinions using a modified Likert-type scale that ranges from "disagree" to "strongly agree." When the values are higher, in the results it indicates that the respondent possesses more of these characteristics. The reliability coefficient Cronbachs alpha showed scores, for both aspects (thinking empathy; $\alpha = 0.88$; feeling empathy; $\alpha = 0.82$).

Executive Function Measures

The Behavioral Rating Inventory of Executive Functions (commonly known as BRIEF) is widely used to evaluate functions, in teenagers specifically The BRIEF was created by Gioia et al in 2000 and is split into two sections focusing metacognition and behavioral regulation. 'Metacognition is the ability to track information and monitor actions during daily activities, and behavioural regulation measures self-regulation and proper behaviour' (Anderson et al., 2009; McAuley et al., 2010). It attempts to measure eight subcomponents of the executive functions, which include inhibition, cognitive flexibility, working memory, planning, task initiation, emotional control, organisation of materials, and monitoring of

behavior (Anderson et al., 2009; Toplak et al., 2013). On this scale, there are two areas that are completed by the teachers and parents. In the current study, the teachers' form was used, and only five of the executive functions were selected. The psychometric properties of the scale were already determined using Cronbach alpha reliability techniques, and it's shown that for the global executive function composite score: $\alpha=0.97$; inhibition $\alpha=0.94$; cognitive flexibility $\alpha=0.90$; emotional control $\alpha=0.91$; working memory $\alpha=0.94$; plan/organise $\alpha=0.97$.

Data Collection Procedure /Statistical Analysis

The instrument was administered to all the participants of the study under the close monitoring of the researchers and assistants in various schools and homes where these respondents were identified. First, the Reniers et al. (2011) scale on cognitive and affective empathy (CAES) was presented to the subjects, and they were asked to respond. Those with difficulties were assisted by researchers and their parents, who have already provided consent to the study. Secondly, the Behavioural Rating Inventory of Executive Functions (BRIEF) was completed by teachers in the schools where the respondents were elected. The researchers explained to teachers how to complete the questionnaire. This was done accordingly, and there was a 100% return rate. The collected data were analysed with Microsoft Excel and Statistical Package for Social Sciences (SPSS) version 20.0. Statistical indices such as mean, standard deviation, and other statistical information are presented appropriately.

Data Analysis and Interpretation

The descriptive statistics for all the variables used in the study are presented with the intercorrelation matrix of the variables. The descriptive statistics showed that cognitive flexibility has a mean of 19.5 with a standard deviation of 2.3. No significant correlations were found with other variables. Planning has a mean of 18.9 with a standard deviation of 2.9. It shows a significant positive correlation with working memory ($r = 0.16^*$). Working memory, with a mean of 20.4 and a standard deviation of 2.8, exhibits significant positive correlations with planning ($r = 0.16^*$) and inhibitor control ($r = 0.45^*$). Inhibitor control has a mean of 17.6 with a standard deviation of 2.3. It does not show significant correlations with other variables. Emotional control, with a mean of 19.9 and a standard deviation of 2.1, correlates significantly positively with planning ($r = 0.13^*$), emotional control ($r = 0.20^*$), and affective empathy ($r = 0.18^*$). Cognitive empathy has a mean of 19.5 with a standard deviation of 1.7. It shows positive correlations with emotional control ($r = 0.38^*$), affective empathy, with a mean of 30.9 and a standard deviation of 2.5, correlates significantly positively with emotional control ($r = 0.53^*$), cognitive empathy ($r = 0.60^*$), and affective empathy ($r = 0.18^*$). The correlations suggest intricate relationships between cognitive and emotional variables, highlighting the interconnected nature of these processes. These findings contribute to a deeper understanding of the cognitive and emotional dimensions in the study's context.

Table 1: Descriptive statistics of the variables

	M	SD	SE	1	2	3	4	5	6	7
Cognitive flexibility (1)	19.5	2.3	.12	1						
Planning (2)	18.9	2.9	.15	.16*	1					
Working Memory (3)	20.4	2.8	.15	.45*	.42*	1				
Inhibitor control (4)	17.6	2.3	.12	-.05	.04	-.07	1			
Emotional control (5)	19.9	2.1	.11	.13*	.53*	.17	.04	1		
Cognitive Empathy (6)	19.5	1.7	.09	.38*	.26*	.21*	.43*	.69**	1	
Affective Empathy (7)	30.9	2.5	.13	.53*	.21*	.69*	.38*	.45**	.18	1

M=Mean ; SD=Standard deviation, SE=Standard Error

Table 2 contains the results of research question 1. The regression coefficient (B) of 0.465 suggests that for each unit increase in cognitive flexibility, there is a predicted increase of 0.465 units in cognitive empathy. The high t-cal. value (15.427) and the significant p-value (< 0.001) indicate a strong and significant relationship. The R² value of 0.420 suggests that cognitive flexibility explains 42% of the variability in cognitive empathy. Similarly, the regression coefficient (B) for affective empathy is 0.617, indicating that for each unit increase in cognitive flexibility, there is a predicted increase of 0.617 units in affective empathy. The t-cal value (12.305) is high, and the p-value is < 0.001 , signifying a robust and significant relationship. The R² value of 0.306 indicates that cognitive flexibility accounts for 30.6% of the variability in affective empathy. Thus, the null hypothesis is rejected, which stated that there is no significant relative effect of significant flexibility on cognitive and affective empathy among students with autism disorder.

Table 2: Bootstrapped simple linear regression analysis of the relative effect of cognitive flexibility on cognitive and affective empathy

Measures	β	Mean	Std Dev	Std Error	t-cal	95% CI	Other Parameters
Cognitive empathy	.465	19.518	1.651	.026	15.427	[.411, .514]	R=.640,R ² =.420, Adj R ² =.408, F=237.98*, p<.001
Affective empathy	.617	30.884	2.534	.047	12.305	[.522, .706]	R=.553,R ² =.306, Adj R ² =.304, F=151.42*, p<.001

*=Significant at .05 level

The result for research question 2 as presented in Table 3 showed that the regression coefficient (B) of 0.614 indicates that, for each unit increase in working memory, there is a predicted increase of 0.614 units in cognitive empathy. The t-cal value of 14.418 is high, and the p-value is < 0.001 , suggesting a robust and significant relationship. The R² value of 0.377 indicates that working memory explains 37.7% of the variability in cognitive empathy. The 95% confidence interval for B is [0.316, 0.400], indicating that we are 95% confident that the true effect lies within this interval. Similar to working memory and affective empathy, the regression coefficient (B) of 0.696 indicates that, for each unit increase in working memory, there is a predicted increase of 0.696 units in affective empathy. The t-cal value of 17.960 is high, and the p-value is < 0.001 , indicating a strong and significant relationship. The R² value of 0.485 suggests that working memory accounts for 48.5% of the variability in affective empathy. The 95% confidence interval for B is [0.564, 0.675], indicating that we are 95% confident that the true effect lies within this interval.

Table 3: Bootstrapped Simple linear regression analysis of the relative effect of working memory on cognitive and affective empathy

Measures	β	Mean	Std Dev	Std Error	t-cal	95% CI	Other Parameters
Cognitive empathy	.614	19.518	1.651	.021	14.418	[.316, .400]	R=.614,R ² =.377, Adj R ² =.376, F=207.88*, p<.001
Affective empathy	.696	30.884	2.534	.028	17.960	[.564, .675]	R=.696,R ² =.485, Adj R ² =.483, F=322.561*, p<.001

*=Significant at .05 level

The result of question 3 as presented in Table 4 showed that the regression coefficient (B) of 0.150 indicates that, for each unit increase in planning for the future, there is a predicted increase of 0.150 units in cognitive empathy. The t-cal value of 5.051 is significant ($p < 0.001$), suggesting a moderate and significant relationship. The R² value of 0.069 indicates that planning for the future explains 6.9% of the variability in cognitive empathy. The 95% confidence interval for B is [0.094, 0.202], providing a range within which we are 95% confident the true effect lies. More so, for planning for the future and affective empathy, The regression coefficient (B) of 0.404 indicates that, for each unit increase in planning for the future, there is a predicted increase

of 0.404 units in affective empathy. The t-cal value of 9.032 is significant ($p < 0.001$), indicating a substantial and significant relationship. The R2 value of 0.213 suggests that planning for the future explains 21.3% of the variability in affective empathy. The 95% confidence interval for B is [0.327, 0.477], providing a range within which we are 95% confident the true effect lies.

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the future explains 6.9% of the variability in cognitive empathy. The 95% confidence interval for B is [0.094, 0.202], providing a range within which we are 95% confident the true effect lies. More so, for planning for the future and affective empathy, The regression coefficient (B) of 0.404 indicates that, for each unit increase in planning for the future, there is a predicted increase of 0.404 units in affective empathy. The t-cal value of 9.032 is significant ($p < 0.001$), indicating a substantial and significant relationship. The R2 value of 0.213 suggests that planning for the future explains 21.3% of the variability in affective empathy. The 95% confidence interval for B is [0.327, 0.477], providing a range within which we are 95% confident the true effect lies.

Table 4: Bootstrapped Simple linear regression analysis of the relative effect of planning for the future on cognitive and affective empathy

Measures	β	Mean	Std Dev	Std Error	t-cal	95% CI	Other Parameters
Cognitive empathy	.150	19.518	1.651	.027	5.051	[.094, .202]	R=.263, R ² =.069, Adj R ² =.067, F=25.508*, p<.001
Affective empathy	.404	30.884	2.534	.039	9.032	[.327, .477}	R=.461, R ² =.213, Adj R ² =.211, F=392.775*, p<.001

*=Significant at .05 level

The result of question 4 as presented in Table 5 showed that the regression coefficient (B) of 0.310 indicates that, for each unit increase in inhibition control, there is a predicted increase of 0.310 units in cognitive empathy. The t-cal value of 8.779 is significant ($p < 0.001$), suggesting a substantial and significant relationship. The R2 value of 0.183 suggests that inhibition control explains 18.3% of the variability in cognitive empathy. The 95% confidence interval for B is [0.245, 0.382], providing a range within which we are 95% confident the true effect lies. Similarly, the result of inhibitors control and affective empathy, the regression coefficient (B) of 0.427 indicates that, for each unit increase in inhibition control, there is a predicted increase of 0.427 units in affective empathy. The t-cal value of 7.702 is significant ($p < 0.001$), indicating a significant and meaningful relationship. The R2 value of 0.147 suggests that inhibition control explains 14.7% of the variability in affective empathy. The 95% confidence interval for B is [0.331, 0.511], providing a range within which we are 95% confident the true effect lies. This implies that the null hypothesis is rejected and the alternate hypotheses upheld.

Table 5: Bootstrapped Simple linear regression analysis of the relative effect of inhibition control on cognitive and affective empathy

Measures	β	Mean	Std Dev	Std Error	t-cal	95% CI	Other Parameters
Cognitive empathy	.310	19.518	1.651	.035	8.779	[.245 .382]	R=.428, R ² =.183, Adj R ² =.181, F=77.03*, p<.001
Affective empathy	.427	30.884	2.534	.047	7.702	[.331, .511}	R=.384, R ² =.147, Adj R ² =.145, F=59.317*, p<.001

*=Significant at .05 level

The result of question 5 as presented in Table 6 showed that the regression coefficient (B) of 0.545 indicates that, for each unit increase in emotional control, there is a predicted increase of 0.545 units in cognitive empathy. The t-cal value of 18.093 is highly significant ($p < 0.001$), suggesting a robust and meaningful relationship. The R2 value of 0.488 indicates that emotional control explains 48.8% of the variability in cognitive empathy. The 95% confidence interval for B is [0.493, 0.596], providing a range within which we are 95% confident the true effect lies. This suggests that, on average, the true effect of emotional control on cognitive empathy is likely to be within this interval. For emotional control and cognitive empathy. Similarly for emotional control and affective empathy, the regression coefficient (B) of 0.943 indicates that, for each unit increase in emotional control, there is a predicted increase of 0.943 units in affective empathy. The t-cal value of 23.784 is highly significant ($p < 0.001$), indicating a strong and meaningful relationship. The R2 value of 0.623 suggests that emotional control explains 62.3% of the variability in affective empathy. The 95% confidence interval for B is [0.880, 0.924], providing a range within which we are 95% confident the true effect lies. This suggests that, on average, the true effect of emotional control on affective empathy is likely to be within this interval. The results indicate a statistically significant positive effect of emotional control on both cognitive and affective empathy. Emotional control appears to be a potent factor in predicting empathic abilities.

Table 6: Bootstrapped Simple linear regression analysis of the relative effect of emotional control on cognitive and affective empathy

Measures	β	Mean	Std Dev	Std Error	t-cal	95% CI	Other Parameters
Cognitive empathy	.545	19.518	1.651	.027	18.093	[.493 .596]	R=.699, R ² =.488, Adj R ² =.487, F=327.37*, p<.001
Affective empathy	.943	30.884	2.534	.031	23.784	[.880, .924]	R=.789, R ² =.623, Adj R ² =.621, F=565.56*, p<.001

*=Significant at .05 level

Discussion of Findings

The regression analysis results show that cognitive flexibility has a statistically significant positive influence on both cognitive and emotional empathy among students with autism. The rejection of the null hypothesis indicates that there is a significant link between cognitive flexibility and empathy in this cohort. The rationale for this finding could be that children with ASD with higher cognitive flexibility are better suited to identify and help the issues of others, resulting in superior empathetic capacities. Furthermore, empathy takes a high level of cognitive ability. Individuals with autism disorder who display greater cognitive flexibility may be able to negotiate social settings more efficiently, resulting in increased cognitive empathy. Similarly, in terms of affective empathy, the ability of this population to transfer attention, interpreting others' emotional conditions and adapting to their emotional responses could lead to improved affective empathy. The findings are consistent with those of Mazza et al. (2014), who found that cognitive flexibility is necessary for children with ADS to have empathic qualities. However, it should be noted that individuals with autism disorder frequently face social communication issues, and hence those with cognitive inflexibility may be unable to respond to social processing, compromising their empathic capacities. This implies that interventions that focus on cognitive flexibility and social cognitions are critical.

The results of hypothesis two show that working memory has a notable and statistically significant positive influence on both cognitive and emotional empathy in students with autism disorder. This research indicates a strong link between working memory capacity and empathy expression in this population. The study's findings could be attributed to the fact that persons with excellent working memory may be able to manage processes and analyse social events, allowing for a more complex grasp of other people's points of view, emotions, and perspectives. Furthermore, persons with autism disorder's affective empathy may have an impact on self-regulation, which could be aided by an effectively functioning memory. Similarly, other researchers have noted that working memory as an executive function is one of the challenges for those with this disorder (Baron-Cohen, 2009); thus, the positive relationship between these two variables may imply that students with this altruistic condition who have strong working memory may navigate social interactions more effectively, leading to improved cognitive and affective empathy. Furthermore, working memory serves as a cognitive workspace, helping people to integrate and absorb information from numerous sources. In the context of empathy, this integration may allow individuals to examine different aspects of a social situation, resulting

in a more complete comprehension of others' emotions and viewpoints (Pellicano et al. 2014).

The result for hypothesis 3, which showed that there is a statistically significant positive effect of planning on both cognitive and affective empathy among students with autism disorder, The result is an indication that students with autism disorder who exhibit strong planning abilities have the tendency to show concern for other people's situations and problems. The results could also be due to the fact that this is an activity that involves future-oriented activities through thinking and anticipation of future consequences. Individuals who have these planning skills may be better equipped to get prepared to understand others when such needs arise. This forward-thinking aspect of planning could contribute to a more nuanced grasp of social situations (Müller et al., 2016). Affective empathy, which involves emotional sharing and responsiveness, may benefit from effective emotional regulation associated with planning skills. Individuals who engage in effective planning might be more adept at regulating their own emotions, leading to heightened affective empathy as they navigate emotional experiences, both their own and those of others (Mazefsky et al., 2013). Therefore, planning as an executive function could contribute to individuals having a more adaptive social behaviour, which can trigger better empathic responses from those with autism (Kenworthy et al., 2005). In the same explanation of the rationale for the result, Zelazo et al. (2016) added that since planning is looking at the future and involves adaptability to social situations, it leads to both cognitive and affective empathy.

The finding that there is a statistically significant positive effect of inhibitor control on both cognitive and affective empathy among students with autism disorder is intriguing and may have several implications. First, the result could be due to the fact that inhibitory control, which is essential in cognitive functioning, is also essential in social interaction and psychological dispositions. Individuals with autism sometimes struggle in settings because they find it hard to grasp and react to signals appropriately. Improved control over impulses could help them handle actions better and enhance their participation, in settings. Likewise, the ability to control ones impulses also influences perspective taking. An aspect of understanding others feelings and thoughts. Having an ability to control impulses might aid in considering others perspectives. Ultimately boost cognitive empathy. The ability to inhibit one's own perspective and consider the viewpoint of others may be facilitated by strong inhibitor control, leading to improved cognitive empathy. The findings could be explained

by the fact that effective inhibitor control may contribute to improved emotion regulation, helping people with autism to navigate emotionally intense social situations more effectively. Individuals with autism who undergo particular training or therapies aimed at improving inhibitor control abilities may also experience increases in cognitive and affective empathy. These therapies could target on improving executive skills, such as inhibitor control. It is also possible that the relationship between inhibitor control and empathy in autism is complex and influenced by a number of factors, including genetic, neurological, and environmental. More research may be required to investigate these complicated relationships. The findings are consistent with earlier research that has indicated that inhibitory controls are required for pupils to show empathy to others.

The discovery of a positive statistically significant association between emotional control and both cognitive and affective empathy in children with ASD is noteworthy and merits further discussion. It's crucial to note that interpretations can differ, and the following analysis is based on general psychological principles. The findings could be attributed to the fact that emotional control involves the regulation of feelings, thoughts, and emotions, and children with ASD who can control their emotions may be able to understand others, which may contribute to their ability to interpret and align with other people's emotions. Furthermore, children with greater emotional control may be able to perceive what happens around them, leading to increased cognitive empathy. Similarly, the findings could be interpreted as implying that children with ASD with improved emotional regulation may be better able to moderate their emotional responses, allowing them to better resonate with and comprehend the feelings of others. Furthermore, autistic children who can regulate their emotions may be more sensitive to the emotional nuances in social interactions, resulting in increased affective empathy. The findings are consistent with previous study (Zhou et al., 2012; Lan et al., 2011). This talent could help you form more meaningful ties with others. However, developmental factors cannot be totally ruled out as influences on the link between emotional control and empathy. As autistic children develop, gains in emotional regulation may correlate with.

Conclusion

The conclusion from the study is that, although students identified with ASD may experience challenges in areas such as empathizing with others and executive functioning including planning, organizing, and completing tasks, they also demonstrate potential for growth and meaningful participation in society. With appropriate support, understanding, and inclusive practices, these students can build on their strengths and lead fulfilling lives as valued members of their communities. The result showed that these executive functions relatively and compositely, can stimulate empathy, cognitively and affectively in children with ASD empathy level. The findings of the study have much to learn about especially as students who are able to plan, regulate themselves as well as inhibit tendencies are able to manage the social environment is created that provides

opportunities to get to understand the feelings of others appreciate what they go through. The findings also revealed that executive functions when combined which research have identified to be challenging to the children with ASD due to their inability to relate with other, communication barriers are potent factors that help them develop this empathetic spirit. It is important that interventions that can help these students be carried especially in the area of self-regulation and emotional control so that they will be helped to relate well with others, take decisions that will be meaningful in life as well as adjust appropriately to the demands of their environment.

Limitations of the Study

The paper like any other studies is a survey study that depends on self-reports that may contain a lot of bias in responses to the items in the questionnaire. Thus, certain responses that were produced may not be true of the attributes measured. More so, some of the items were in the questionnaires were responded to by the teachers who are subjects to errors in their judgement of the various students with this condition. Similarly, the findings of the study may not be generalized to other parts of the country since the respondents that were used were majorly from Nigeria. More so, the difficulties associated with these students may be a barrier in itself as some of the students have inherent problems that may affect their response to the items in the questionnaire. However, despite these limitations, the study contributes meaningful insights into the factors associated with empathy both cognitive and affective in children with ASD. These findings can inform future research directions and offer a foundation for further exploration of empathy development in diverse cultural settings.

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Conflict of Interest

No conflict of interest was recorded.

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Ethical Consideration

The study was a cross-sectional survey which according to the Federal Ministry of Health (2017) can receive waive of ethical approval. This is because the study does not potent harm to the subjects. However, ethical issues were placed at the front of the study because of the special students that were involved. The researchers ensured that 60% of the students especially those with severe autistic conditions' approval were gotten from parents. The parents were given the consent form to sign for the students after explaining the purpose of the study and what the data collected from them will be used for. Secondly, the respondent's data were also secured using an encrypted password to ensure that no third had access to the data that were.

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