Exploring the Relationships Among Executive Functioning, Behaviour, and Adaptive Skills in Young Children

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ABSTRACT

Objectives: This study aimed to investigate the relationship between executive functioning, adaptive skills, and behaviour problems in young children. Participants were divided into four behaviour groups (high internalizing, high externalizing, combined high internalizing and externalizing, and within the normal range). The predictive ability of inhibition, shift, working memory, adaptive skills, age, and gender on group membership were explored. Both variable and person oriented perspectives were examined.

Methods: 55 kindergarten and Grade 1 educators in Ontario, Canada completed the Behaviour Rating Inventory for Executive Functioning (BRIEFP-TRS; BRIEF2-TRS) and the Behaviour Assessment System for Children (BASC3-TRS) for their students (*N* = 790).

Results: There were significant differences between the four behaviour groups in relation to their levels of executive functioning and adaptive skills. Univariate regression results indicated that all variables were predictors of behaviour group membership. Multivariate analyses showed that shift was the strongest predictor of INT group membership, whereas inhibition was the strongest predictor of EXT and COMB group membership. Cluster analysis results indicated that most children within the normal range of executive functioning were not displaying high levels of behaviour problems; conversely, there were children with executive functioning deficits that were not displaying high levels of behaviour problems.

Implications: Results provide valuable information in relation to the etiology of behaviour problems as well as targeted early intervention practices.

INTRODUCTION

- Executive functions (EFs) are the higher order mental processes that support the planning and execution of goal-directed activity.
- Based on the unity/diversity theory of EF (Hatoum, Rhee, Corley, Hewitt, & Friedman, 2017), EF is usually divided into three main subcomponents:
  - Working memory
  - Inhibition
  - Shift
- Both research and theory posit that both EF and adaptive skills are related to behaviour problems in children (Smith et al., 2017; Brennan, Shaw, Dishion, & Wilson, 2015)
- Behaviour problems are typically divided into two categories:
  - Internalizing behaviour problems (such as depression, anxiety, and somatization), and
  - Externalizing behaviour problems (such as aggression, hyperactivity, and violence)
- Working memory, shift, and inhibition have all been found to uniquely correlate with internalizing and externalizing behaviour problems. A gap exists, however, in relation to the typical population alongside children of a younger age
- Recent research has consistently identified four different psychopathological profiles (Bianchi et al., 2017; Basten, 2013; Blanken et al., 2017; Willner, Gatzke-Kopp, & Bray, 2016), children with:
  1. High levels of externalizing behaviour problems (EXT)
  2. High levels of internalizing behaviour problems (INT)
  3. Combined internalizing and externalizing problems (COMB)
  4. Average levels of behaviour problems (NORM)
- No study to date has examined how the three main EFs or adaptive skills relate to each behaviour profile.
- Identifying patterns related to both impaired cognition and emerging psychopathology at a young age may provide valuable information in relation to behaviour etiology and may inform early intervention practices (Blanken et al., 2017).

Research Questions

1) Are there differences in the executive functioning and adaptive skills profiles across the four behaviour groups?

2) To what extent are executive functions predictive of behaviour group membership in children? Additionally, do variables such as adaptive skills, gender, or age add to the prediction of group membership?

3) When taking a person oriented view, do we see a similar pattern when looking at executive functioning and behaviour?

METHODS

Participants (*N* = 790)

- **Age**: 3 years, *n* = 29 (3.7%), 4-5 years, *n* = 632 (80%), 6-7 years, *n* = 122 (15.4%)
- **Gender:** *n* = 380 (48.1%) boys, *n* = 409 (51.8%) girls

Measures

- **Behaviour Assessment System for Children**, 3rd Edition (BASC-3-TRS-P, BASC-3-TRS-C; Reynolds & Kamphaus, 2015) teacher-rating scales.
  - 3 composite scales:
    - Internalizing behaviour problems
    - Externalizing behaviour problems
    - Adaptive skills
- **Behaviour Rating Inventory of Executive Functioning**, 2nd Edition (BRIEF2-TRS, BRIEFP-TRS (Gioia, 2000; Gioia, Espy & Isquith, 2003)
  - Inhibition scale; Shift scale; Working memory scale; Global Executive Composite (GEC)

Procedure

- Educators completed the measures online prior to implementing the MindUP™ program in a trauma-informed framework (TIF).

Data Analysis

- **One-way ANOVA** (DV = behaviour group; IVs = inhibition, shift, and working memory.
- **Multinomial Logistic Regression:** (IV = behaviour group; DVs = inhibition, shift, working memory, adaptive skills, gender, and age)
- **Two-Step Cluster Analysis and Crosstabulation** (EF cluster analysis by behaviour category)

RESULTS

One-Way ANOVA

- Significant differences were found between the four behaviour groups in relation to their adaptive skills, inhibition, shift, working memory, and GEC (*See Table 1)*
  - Participants in the COMB group had higher levels of inhibition, shift, working memory, and GEC deficits in comparison to the NORM group and the INT group
  - The EXT group had higher levels of inhibition and working memory deficits compared to the INT group
  - The INT group had a higher levels of shifting deficit compared to the EXT group

Table 1
One-Way ANOVA Comparing Independent Variables Across Behavior Groups

	NORM	EXT	INT	COMB	*p*
Adaptive skills[a]	53.7 (8.4)	45.8 (7.7)	45.7 (8.7)	38.1 (7.1)	<0.001
Inhibit[a]	49.5 (9.3)	75.6 (10.2)	54.8 (10.4)	73.0 (8.2)	<0.001
Shift[a]	46.8 (7.8)	52.4 (11.7)	62.8 (13.2)	74.5 (13.3)	<0.001
Working memory[a]	52.2 (11.4)	67.8 (12.9)	60.4 (13.2)	72.9 (12.8)	<0.001
GEC[a]	49.6 (9.7)	69.6 (12.0)	61.5 (11.7)	80.1 (11.2)	<0.001

[a] Data are expressed as Mean (SD)

Multinomial Logistic Regression

- Univariate analyses indicated that inhibition, shift, working memory, GEC, age, and gender were all significantly predictive (*p* = < .001) of behaviour group membership.
  - Males were approximately two times (OR = 2.05) more likely to be in the EXT group compared to females, and were 36% (OR = 1.36) more likely be placed in the COMB category in comparison to females.
  - Students aged 4-5 years old were 47% (OR = 0.53) less likely to be in the INT group compared to those aged 6-7 years.

Table 2
Odds Ratios and Confidence Intervals of Multivariate Multinomial Logistic Regression (N = 712)[a]

	Group 2 (EXT)	Group 3 (INT)	Group 4 (COMB)
Adaptive skills [b,c]	.88 (.82, .95) ***	.94 (.91, .98)**	.79 (.75, .83)***
Inhibit [b,c]	1.36 (1.26, 1.46) ***	1.02 (.98, 1.05)	1.19 (1.14, 1.27)***
Shift [b,c]	.97 (.93, 1.23)	1.13 (1.10, 1.16)***	1.35 (1.08, 1.19)***
Working memory[b,c]	.92 (.88, .97)***	.97 (.94, 1.00)	.92 (.87, .97)**
Age			
Age 3	87 (.10, 7.62)	2.00 (.43, 9.43)	1.78 (.11, 28.36)
Age 4-5	.51 (.17, 1.5)	1.11 (.49, 2.50)	.91 (.23, 3.59)
Age 5-6	1	1	1
Gender			
Male			
Female	3.73 (1.45, 9.68)*	1.07 (.61, 1.89)	3.12 (1.04, 9.37)*
	1	1	1

[a] *Base category in multinomial regression is Low/Low.*
[b] *Estimates are expressed as Adjusted Odds Ratio (95% Confidence intervals [AOR (95% CIs)])*
[c] *Models are adjusted for age and gender*
*AOR is significant at the 0.05 level
**AOR is significant at the 0.01 level
***AOR is significant at the 0.001 level

Table 3
Predictor Contributions in the Multivariate Multinomial Logistic Regression (N =712)

Predictor	χ^2	*df*	*p*
Inhibition	191.150	3	< 0.001
Shift	120.037	3	< 0.001
Working Memory	18.260	3	< 0.001
Adaptive Skills	28.481	3	< 0.001
Age	2.540	6	.864
Gender	10.463	3	.015

Table 4
Multinomial Logistic Regression Model Fitting Information

	-2 Log Likelihood	χ^2	*df*	*p*	Psuedo R-Square (Nagelkerke)
Intercept	1147.096				
EF Model[a]	632.093	497.494	9	<0.001	.63
Final Model[b]	613.371	533.725	21	<0.001	.66

[a] *Model Fitting Information based on inhibition, working memory, and shift only*
[b] *Model Fitting Information based on inhibition, working memory, shift, gender, age, and adaptive skills*

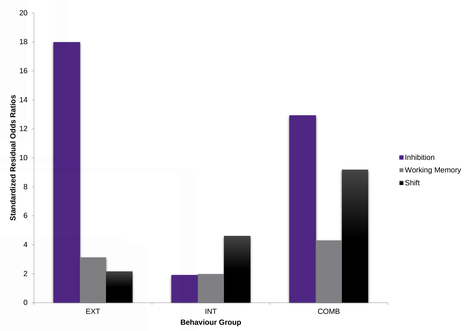

Figure 1. Predictor Strength of Executive Functions based on Multinomial Logistic Regression using Standardized Residual Scores

Cluster Analysis

The two-step cluster analysis divided participants into two groups: 1) A group within the normal range for inhibition (*M* = 47.4), working memory (*M* = 48.7), and shift (*M* = 45.7), and 2) A group with elevated levels of inhibition (*M* = 67.7) working memory (*M* = 71.7), and shifting (*M* = 61.9) deficits.

Table 4
Cross-Tabulation of Two-Step Cluster Analysis Group by Behaviour Group

	NORM	EXT	INT	COMB
Normal Range	456	8	39	2
Elevated	82	47	45	32

SUMMARY AND CONCLUSIONS

1) Are there differences in the executive functioning and adaptive skills profiles across the four behaviour groups?

- There were significant differences between the four behaviour groups based on their executive functioning and adaptive skills.

2) To what extent are executive functions predictive of behaviour group membership in children? Additionally, do variables such as adaptive skills, gender, or age add to the prediction of group membership?

- Individually, inhibition, working memory, shift, adaptive skills, age, and gender were all predictive of behaviour group membership in young children.
- When taken together, significant predictors of behaviour group membership were as follows:
  - **EXT Group:** adaptive skills, inhibition, working memory, and gender
  - **INT Group:** adaptive skills and shift
  - **COMB Group:** adaptive skills, inhibition, shift, working memory, and gender
- Age was no longer predictive of group membership for any behavioural group
- The strongest predictors of group membership were as follows;
  - **EXT group:** inhibition; **INT Group:** shift; **COMB Group:** inhibition, followed closely by shift
- In all cases, increases in adaptive skills were associated with decreased likelihood of being in any of the three behaviour groups.
  - In the final model, the odds of students being in the EXT, INT, and COMB group, respectively, decreased by 12%, 6%, and 21% per one-unit increase in adaptive skills.
- Overall, EF, adaptive skills, age, and gender explained 66% of the variance in behaviour group membership for young children.

3) When taking a person oriented view, do we see a similar pattern when looking at executive functioning and behaviour?

- When taking a person-oriented view, similar results were found, wherein:
  - Most children (90%) who do not have EF deficits are also not displaying high levels of behaviour problems.
  - 40% of those who have elevated levels of EF are not exhibiting high levels of behaviour problems, suggesting that other variables beyond those addressed in this study may account for the unexplained variance in behaviour problems.

IMPLICATIONS

Different etiologies in relation to EF and adaptive skills exist amongst the four behavior groups for young children; therefore, different interventions may be more suitable for children in each group.

- For young children with **internalizing behaviour problems**, interventions targeting shifting ability may be most appropriate
- For young children with **externalizing behaviour problems**, interventions targeting inhibition may be most appropriate
- For young children with **both internalizing and externalizing behaviour problems**, interventions targeting both inhibition and shifting, with a primary focus on inhibition may be most appropriate

Interventions aimed at increasing adaptive skills (such as adaptability, social skills, and functional communication) may reduce the likelihood of young children displaying at-risk to clinical levels of behaviour problems

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