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# Investigating the relationship between executive functions, numeracy and non-verbal reasoning skills in adolescence.

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## Background

**Executive functions (EF)** are a collection of mental control processes that direct cognitive activity. They have repeatedly been found to be associated with **academic attainment**.

(Latzman, Elkovitch, Young, & Clark, 2010; St Clair-Thompson & Gathercole, 2006)

In recent years, **transferable skills** have been accentuated as precursors of pupils' academic attainment.

In order to further understand the association between EFs and academic attainment it may be wise to break it down into simpler components. Therefore, this study looks into the relationship between EFs and two core skills that underpin academic success.

## Methods

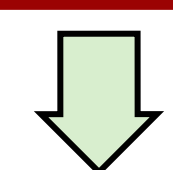
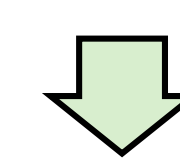
Three EF components (Miyake et al., 2000) were assessed during individual sessions with pupils:

- **Inhibition:** D-KEFS Color-Word Interference task
- **Shifting ability:** D-KEFS Sorting task (first condition)
- **Updating of working memory:** BAS-II Recall of Digits Backward task

### Sample

Third year secondary school pupils (N=108, mean age=14.60, SD=0.41)

Correlational analyses of pupils' scores on the EF and skill tasks were carried out in order to identify any emerging relationships.



Two core skills were measured using pen and paper assessments:

- **Numeracy:** BAS-II Number skills
- **Non-verbal reasoning:** BAS-II Matrices

Multiple linear regression analysis was used to develop models (x2) predicting pupils' numeracy and non-verbal reasoning skills from their scores on EF tasks.

## Results

All EF components were significantly related to one another.

Shifting and Updating were significantly correlated with numeracy skills.

Shifting and Inhibition were significantly correlated with non-verbal reasoning skills.

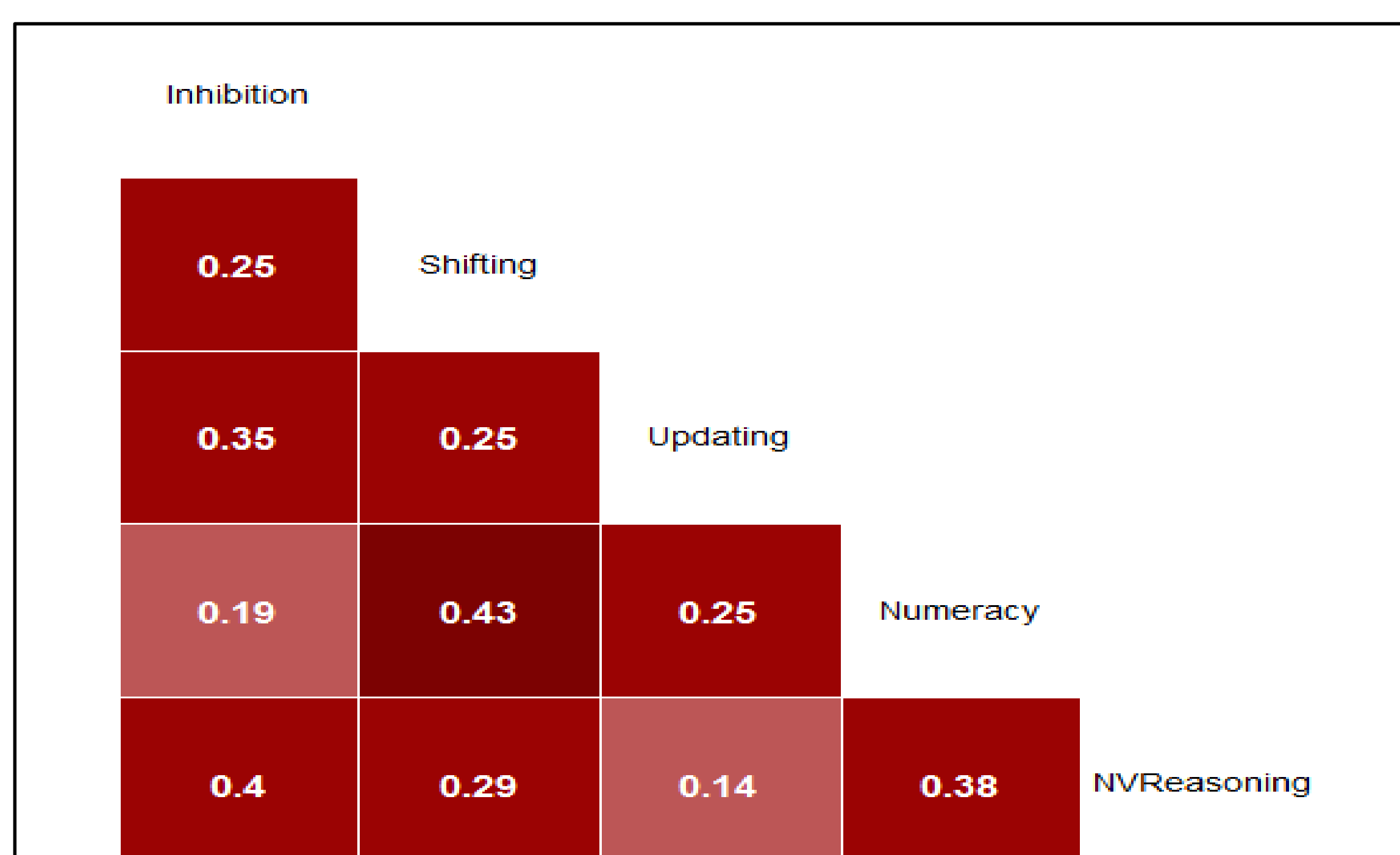


Figure 1: Correlation coefficients among all measures.

Numeracy skills were best predicted by a model including performance on all three EF tasks (Figure 2a).

Non-verbal reasoning skills were best predicted by a model including performance on the Inhibition and Shifting tasks (Figure 2b).

a) Numeracy					b) Non-verbal reasoning						
		$\Delta R^2$	$\beta$	p	AIC			$\Delta R^2$	$\beta$	p	AIC
Step 1	Constant		-0.017	.855		Constant		-0.059	.539		
	Shifting	0.185	0.436	<.001	260.463	Inhibition	0.158	0.470	<.001	259.438	
Step 2	Constant		-0.021	.819		Constant		-0.060	.526		
	Shifting	0.028	0.391	<.001	252.352	Inhibition	0.043	0.417	<.001	256.482	
Step 3	Updating		0.196	.057		Shifting		0.216	.029		
	Constant		-0.010	.918		Constant		-0.056	.565		
Step 3	Shifting		0.403	<.001		Inhibition		0.413	<.001		
	Updating	0.005	0.148	.180	250.730	Shifting	-0.006	0.216	.033	256.765	
Step 3	Inhibition		0.052	.653		Updating		-0.003	.976		

Figure 2: Hierarchical regression analyses predicting a) numeracy and b) non-verbal reasoning skills.

## Conclusions and further plans

Although all the EF components were found to be significantly related to one another, the largest association was that between Updating and Inhibition.

Both the correlational analysis and the regression models suggest there is a relationship between EFs and the core skills of numeracy and non-verbal reasoning.

This study presents the preliminary results of a wider ongoing project, with a total sample of ~400 pupils aged 13-17 and measures of academic attainment (National exams grades) as well as transferable skills, which aims to decipher the relationship between EFs and academic attainment.

## References

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