Disrupting the speech motor mechanism: exploring left hemisphere specialisation for verbal and manual sequencing using a dual task approach

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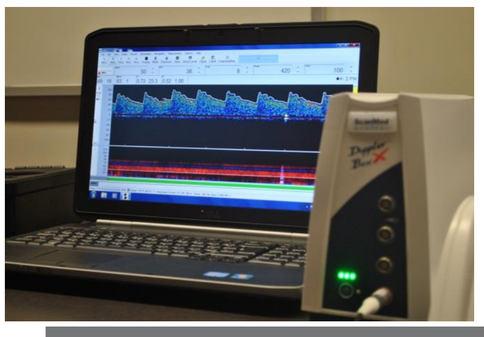
INTRODUCTION

- It is well established that speech production and fine motor praxis are linked neurologically, with evidence indicating that shared left hemisphere networks underpin both functions (e.g. Serrien et al, 2006).
- One suggestion for the crucial component of this left lateralised specialisation is that both speech and praxis rely on effective sequencing of information for their successful execution (Flowers & Hudson, 2013)
- This study was designed to probe the mechanism behind this interaction by overloading the left hemisphere sequencing network via a dual task paradigm.
- It hypothesised that motor and speech tasks linked by a common mechanism would incur greater disruption during increased processing demands than tasks which shared similar properties but did not make use of information sequencing to the same extent.



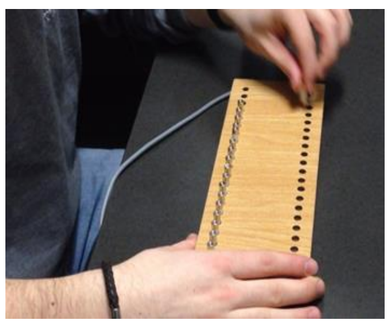
- Performance on this dual-task paradigm was compared to a direct measurement of participants' hemispheric speech lateralisation obtained via functional transcranial Doppler (fTCD) ultrasound.

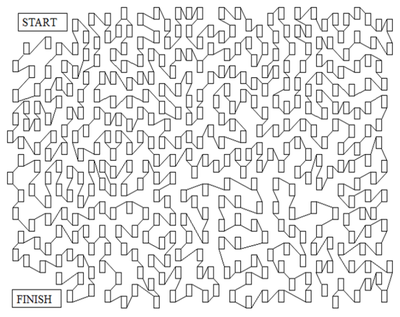
DESIGN & METHODS

Participants: 22 adults (7 males; M_{age}= 20.7yrs, SD_{age}= 4.6yrs)

Dual Task Paradigm:

- A 2x2 repeated measures design consisting of 4 tasks; 2 speech and 2 motor.
- Each task was completed on its own to form the single task phase
- The 4 tasks were then paired into an experimental set and a control set, which were then completed simultaneously to form the dual task phase (see box below)
- Tasks were completed for 2 mins and scored via number of correct responses or movements. Single and dual phases were counterbalanced.
- A dual-task decrement (DTD) score was calculated as follows:





[dual task score – single task score/Single task score] * 100

	Single Task		Dual Task
Experimental Condition	Pegboard	Word Generation	Pegboard & Word Generation
Control Condition	Box Crossing	Digit Recall	Box Crossing & Digit Recall

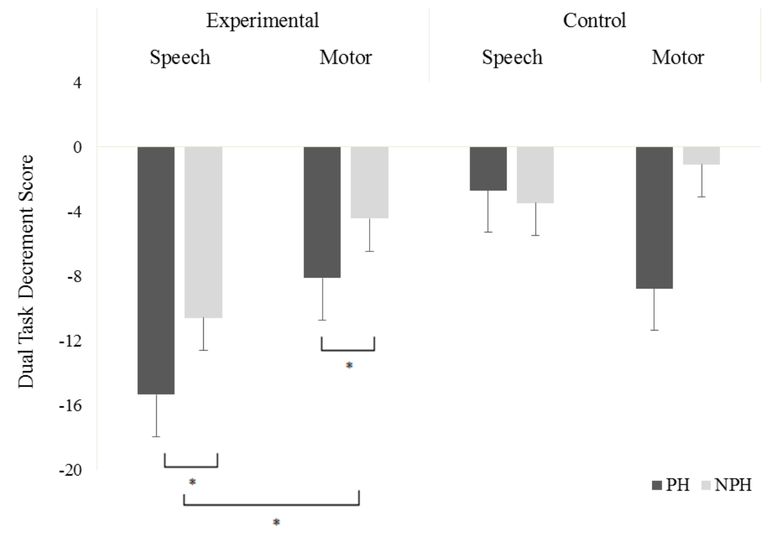
Speech Lateralisation: Subsequent to the dual-task paradigm, a direct measurement of hemispheric activation during speech was obtained via fTCD using the word generation task (Knecht et al, 1998).
Handedness: a hand preference quotient was obtained from responses to a 21 item questionnaire (Flowers & Hudson, 2013)

RESULTS

- Performance in the dual-task phase was worse relative to the single task phase for each of the conditions and tasks. This difference was significant in 4 out of the 8 condition/task combinations.

	PH		Statistics			NPH		Statistics		
	Single	Dual	t	p =	r	Single	Dual	t	p =	r
Word Generation	5.2 (.99)	4.3 (.77)	5.5	.001*	.75	5.2 (.99)	4.4 (.68)	5.3	.001*	.83
Pegboard	103.7 (7.2)	95.5 (12.7)	3.3	.004*	.53	97.68 (8.4)	93.4 (12.5)	1.9	.062	-
Digit Recall	79.4 (14.07)	75.5 (11.8)	1.4	.17	-	79.4 (14.07)	74.6 (14.2)	1.3	.22	-
Box Crossing	179.7 (19.8)	161.7 (28.3)	3.2	.005*	.54	99.9 (20.8)	97.4 (17.4)	.76	.46	-

- A 2x2 repeated measures ANOVA was conducted on the DTD scores using Modality (either speech or motor) and Hand Used (either preferred or non-preferred) as the within subjects variables, and LI score and hand preference as covariates.
- The experimental condition showed a significant main effect of Modality in the DTD scores ($F(1, 18) = 4.21$, $p < .05$; word generation mean DTD score = -12.96; SE = 1.9; Pegboard mean DTD score = -6.27; SE = 2.3).
- There was also a main effect of Hand Used, indicating that the DTD was greater when the preferred hand was doing the pegboard task ($F(1, 18) = 5.72$, $p < .05$; PH mean DTD score = -11.72; SE = 1.82; NPH mean DTD score = -7.5; SE =1.38). No significant effects were found in the control condition.



- There were no significant interactions between the DTD scores and speech lateralisation or hand preference in either condition.

Discussion

- These results reveal the selective disruption to speech production, rather than motor praxis, under dual task conditions
- Data support theories suggesting a gestural origin to speech, by indicating that language is making use of a more 'hard wired' motor praxis system controlled by left hemisphere networks optimised for sequential information processing (Flowers and Hudson, 2013).
- The lack of interaction between DTD scores and speech LI was surprising, but possibly reflects the predominantly left lateralised sample.
- Future work will focus on isolating the common components linking the functions, and will also look at dual task performance of individuals with developmental motor and language deficits.

References: Flowers and Hudson (2013). *Neuropsychology, 27*, 256-65; Knecht et al (1998). *Stroke, 29*, 82-86; Serrien et al (2006). *Nat. Rev. Neurosci., 7*, 160-166

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