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Experimental Artefacts in Aphasia Research: How Experimental Variables Raise Semantic over Phonological Errors in Conduction Aphasia

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Introduction

A long-standing pretension of case studies in aphasia research is to follow experimental procedures that warrant the results obtained and allow generalization. Despite this, as our knowledge of the relevance of different characteristic of the stimuli (frequency, concreteness) and experimental conditions (blocks, repeated naming, memory load) get moving, it is evident that some unexpected patterns described in the literature are easily explained as consequence of lack of experimental control. Namely, the STEPS constitutes a behavioral pattern in which people with aphasia produce more phonemic (phonological) errors with non-number words (e.g., tale → *lale*) whereas more semantic errors with numbers (e.g., 42 → 13) (Dotan & Friedmann, 2015). Currently, STEPS is explained by the Building Blocks Hypothesis, an account that locates the emergence of the semantic errors in the phonological output buffer (POB). Recently, we showed evidence that STEPS was not related to the damage of the POB (García-Orza et al., 2020). However, here we explore the nature of the STEPS from an interactionist perspective (e.g., Martin et al., 1996). Interactionist models would allow to explain the emergence of semantic errors – over phonemic errors– when assessing numbers, since they are high-frequency elements which are presented in semantically homogeneous lists under conditions of increased cognitive (memory) load (e.g., numbers of increasing length). Specifically, we compare the production of multidigit numbers (composed of high-frequency number words) with the production of sequences (2-4 words) of high-frequency vs low-frequency colors. It is hypothesized that more semantic errors will arise in high-frequency color sequences, whereas more phonemic errors will arise with low-frequency sequences. It is also expected that memory load facilitates the appearance of these errors.

Methods

Two female patients with conduction aphasia – ML, of repetition variety (phonological input buffer) and DNR, of the reproduction variety (POB) – were assessed in three production tasks (naming, reading and repetition) with multidigit numbers (e.g., 452) as well as with high-frequency and low-frequency color sequences (e.g., green-red-blue and lilac-mallow-beige, respectively).

Results

Both patients committed more semantic than phonemic errors while producing numbers and high-frequency color sequences, in both cases phonemic errors were scarce. On the contrary, phonemic errors arose while producing sequences of low-frequency colors (**see Figure 1**). Additional analyses on the length evidenced – for both patients – an increase of semantic errors for numbers and high-frequency colors while producing longer sequences. Both phonemic and formal errors showed non-significant differences across lengths, only a tendency to increase in one patient (DNR) (**see Table 1**).

Conclusions

Our results indicate: a) frequency plays a role in the emergence of semantic (high-frequency) vs phonemic (low-frequency) errors; b) the emergence of errors is directly proportional to memory load as indexed by the number of words in the sequence. These data support that the STEPS effect seems to be an "experimental artefact" defined by the interaction of different variables such as lexical frequency, semantic context, and memory load during speech production. Our findings open a window to the discussion on how speech errors are given birth in aphasia and how they can be manipulated.

References

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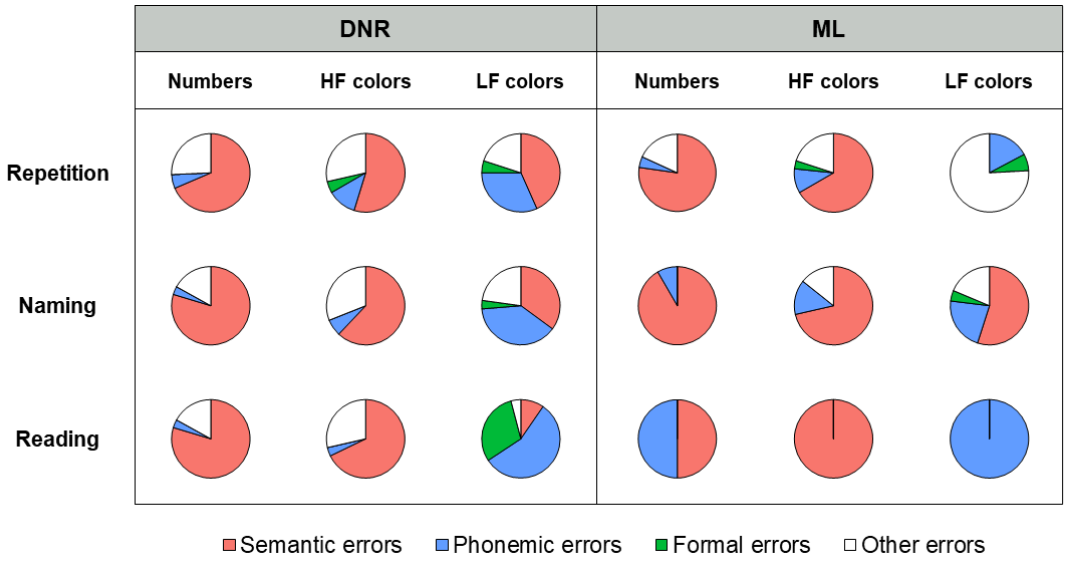

Figure 1. Types of errors committed by both patients in the different stimulus types (HF = high-frequency, LF = low-frequency).

Table 1. Amount of error types per patients according to stimulus type and length (number of elements). Note: Total number of errors includes semantic, phonemic, formal and other errors like perseverations, omissions…).

Patient	Error type	Numbers			HF colors			LF colors		
		2	3	4	2	3	4	2	3	4
DNR	Semantic	6	19	28	12	30	36	31	39	36
	Phonemic	16	34	32	2	2	6	1	0	3
	Formal	4	8	15	0	1	1	0	0	0
	Total	31	69	90	22	45	61	38	52	61
ML	Semantic	15	17	18	7	17	23	4	22	23
	Phonemic	11	8	9	0	3	4	0	5	2
	Formal	3	2	1	2	0	0	0	0	0
	Total	55	35	33	10	22	37	4	31	29