Getting Unstuck

Compounding Factors of Treatment-Related Inflexible Partial-Skill Learning

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BACKGROUND

After trialing a treatment based on implicit priming for a person with aphasia, we found that they were getting 'stuck' on the syntactic structures we were training. In an attempt to figure out why, we tested their cognitive flexibility to determine if this played a role in the perseverative nature of their responses. Their scores indicated that this executive function was a significant deficit for them.

This study investigates if these results extrapolate to more than just this individual, and explores what happens when we vary input, or keep it consistent.

Accounts of learning state that we enter three different stages while learning a task[8]:

1. **Variability**: *trial-and-error, sometimes right, sometimes wrong*
2. **Stability**: *always accurate, but reliant on rules and context-bound*
3. **Flexibility**: *can use learned skill in novel contexts under new circumstances*

We propose an intermediary between task mastery (stability) and true learning (flexibility): ***inflexible partial-skill learning***
Generalization is required for true learning[2,6,10]

THE DATIVE ALTERNATION

Grammatical structures often come in "pairs", or alternations. The dative structure was used for all stimuli in this experiment. All dative sentences convey a transfer of an object from an agent ('giver') to a patient ('receiver')[1].

Sentence components:

Agent: the boy

Verb: is giving

Patient: his teacher

Object: an apple

Double-object dative (DO): *(agent) (verb) (patient) (object)*
Ex: The boy is giving his teacher an apple

Prepositional dative (DP): *(agent) (verb) (object) (to (patient)*
Ex: The boy is giving an apple to his teacher

THE KEY DIFFERENCE: word order; prepositional datives contain the patient (recipient) in a prepositional phrase at the end of the sentence

WHAT IS THE SAME: the content, the conveyed message, and the thematic roles

METHODS AND PREDICTORS

❖ **Dative preference test**
We determined if each participant preferred the double object dative, the prepositional dative, or had no preference with a receptive listening task
predictor: ***preference***

❖ Tests of cognitive flexibility
Wisconsin Card Sorting Test (WCST)
Participants must sort cards in whatever way they see fit and modulate responses based on yes/no feedback. Once participants deduce the sorting rule (determined by getting 10 correct matches in a row) the rule changes. Participants are not informed of the rule change, they must deduce this based on changes to feedback[5].
predictor: ***WCST*** *(perseverative errors)*
**a perseverative error is when participants respond based on the previous sorting rule, instead of flexibly switching to the new rule*

Dimensional Change Card Sort (DCCS)
Secondary measure of cognitive flexibility. Participants must match a picture to one of two sorting pictures based on either color or shape depending on the prompt. This task is very explicit but still requires cognitive flexibility to complete accurately.
*Excluded from analyses (see: ancillary finding)**

❖ **Implicit priming experimental task**
EXPOSURE PHASE:
Participants saw a model image and heard a double-object dative sentence to describe it. A new target image appeared, and participants described the new image out loud. Each model-target image pair counts as 1 trial. The exposure phase had 25 trials. We determined how many times participants repeated the model structure in their own productions, evidence of syntactic priming.
predictor: ***priming***
TEST PHASE:
Participants saw a model image and heard either a filler (non-dative) or a prepositional dative sentence to describe it. A new target image appeared, and participants described the new image out loud. The test phase had 24 trials. We determined the number of times participants referred back to the modeled structure from the exposure phase (DO) during the test phase, evidence of *syntactic perseveration*. We also determined the number of times participants switched grammatical structure during the test phase (i.e., produced one structure for a trial, and then produced a different structure for the next trial).
predictors: ***syntactic perseveration*** *(outcome variable); switches*

STUDY AIMS

1. Investigate if cognitive flexibility predicts an individual's affinity to perseverate on a modeled syntactic structure (i.e., "get stuck")

2. Assess if other factors predict how often an individual will perseverate on a modeled syntactic structure (group assignment, priming affinity, dative preference, or number of switches)

PARTICIPANTS

INCLUSION CRITERIA
-Between 18-35 years of age
-Proficient monolingual English speaker (bi-/multilingual speakers may have advanced cognitive flexibility skills)[9]
-Limited exposure to language structure (i.e., have not taken a college-level linguistics course)
-Report no language or learning disabilities (ADHD, DLD, dyslexia, etc.)
-Have normal/corrected-to-normal vision and hearing

Participants recruited via SONA (the university's psychology testing pool)
N=38

RESULTS

Statistical model selected: **Beta-Binomial regression** (glmmTMB package in R)
Reason for model selection: bounded count outcome variable; data overdispersion (ϕ = 12.7)

Predictor	Estimate (b)	Std. Error	Z-value	p-value
priming	**0.086**	**0.037**	**2.300**	**0.021***
WCST	**-0.421**	**0.150**	**-2.803**	**0.005****
switches	**0.151**	**0.036**	**4.181**	**<.001*****
group	-0.087	0.297	-0.294	0.769
preference	-0.003	0.004	-0.566	.572
priming*WCST	**0.022**	**0.007**	**3.092**	**.002****
(Intercept)	-3.677	0.816	-4.503	<.001*

MAIN EFFECTS

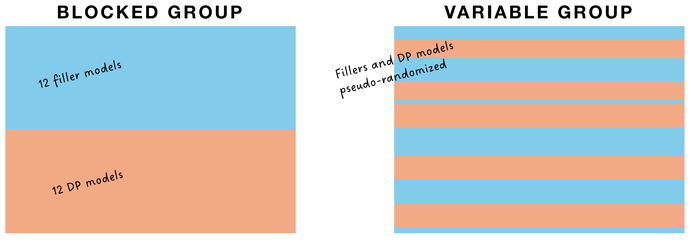
⬆ Priming = ⬆ syntactic perseveration

⬆ WCST errors = ⬇ syntactic perseveration
***main effects assume all other predictors are at 0*
*(see priming*WCST interaction for explanation)*

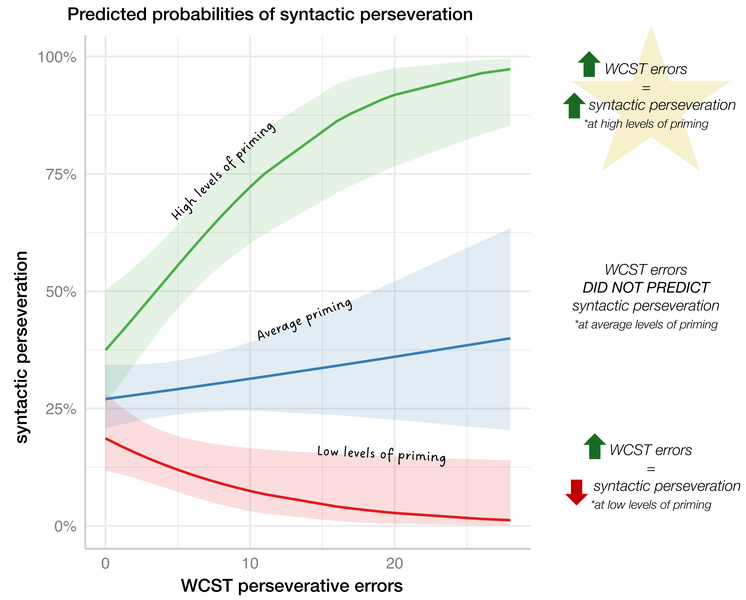
⬆ Switches = ⬆ syntactic perseveration

GROUP ASSIGNMENT

The test phase of the experimental task varied based on group assignment. Group assignment was interleaved. In the *blocked* group, model sentences were fillers for the first 12 trials and prepositional datives for the next 12 trials. In the *variable* group, model sentences were pseudo-randomized, but participants still heard 12 fillers and 12 prepositional datives total.
predictor: ***group***



PRIMING * WCST INTERACTION



ANCILLARY FINDING

Our two measures of cognitive flexibility, which theoretically measure the same construct, were not correlated *(Spearman's rho = 0.099, p=.556).* This finding resulted in the **removal of the DCCS** scores from our statistical model, as it decreased model fit, and was not correlated with any other predictors in the model. Since the two tasks (WCST and DCCS) differ in explicitness, they may require slightly different executive functioning abilities to complete accurately.

Cognitive flexibility is a loosely defined construct, and as such, measures of this executive function may not reflect the same aspects of it[3,7].

CONCLUSIONS

❖ Cognitive flexibility (perseverative errors on the WCST) predicted syntactic perseveration only among individuals who had a high affinity for priming.

❖ Individuals who had a low affinity for priming did not perseverate on the modeled syntactic structure, indicating *production* of the structure drives perseveration, rather than passively hearing it[4].

❖ The WCST and DCCS were not correlated. This supports the idea that cognitive flexibility is a loose construct and multiple measures of cognitive flexibility may not be comparable as they measure slightly different aspects of the executive function[3,7].

❖ There was no significant effect of group, indicating that inducing variability in the test phase had no effect on the amount participants perseverated.

FUTURE DIRECTIONS

❖ Evaluate the impact of a variable exposure phase. What happens when we start with variability, as opposed to inducing it later?
❖ Results inform treatment paradigms utilizing syntactic priming and encourage evaluation of cognitive flexibility for individuals who may be undergoing treatment involving implicit syntactic priming

LIMITATIONS

❖ Small sample size

❖ Cognitive flexibility is a loosely defined construct, therefore studies utilizing measures of this executive function may lack construct validity

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