The Effect of Feedback Consistency on Learning in Children

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Introduction

It is suggested that the ability to use feedback effectively to facilitate learning is a developing ability. The present study evaluated whether the consistency of feedback affects learning outcomes and feedback processing in children, and the extent to which measures of working memory and self-efficacy are related to children's ability to withstand instances of inconsistent feedback during learning.

Method

Task
- 119 children (55 females; 63 males) between the ages of 7 and 10 years
- (Mean = 9.35, SD = 1.06)
- Participants were tasked with sorting items into two bins based on the category to which they belonged (total of 8 categories).
  - **Consistent Condition**: performance feedback was always consistent with the participants' responses.
  - **Inconsistent Condition**: feedback was consistent on 80% of the trials, while on 20% of the trials, participants received the wrong feedback.

Consistent Condition

Inconsistent Condition
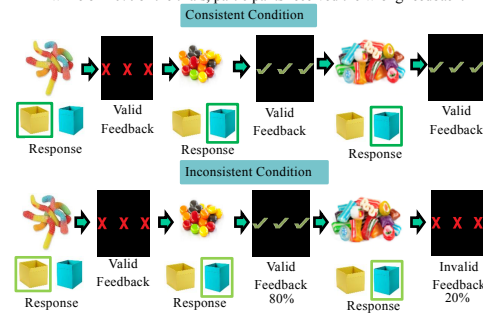
Additional Measure
- **Working Memory**: Number Repetition and Familiar Sequences subtests of the CELF-4.
- **Self-Efficacy**: Perceived Control measure from the Student Perceptions of Control Questionnaire (SPOCQ)

EEG Data Collection and Analysis
- EEG data were collected from 32 electrodes using a 32-channel GES 400 System by Electrical Geodesics Inc. (EGI)
- EEG data were time-locked to the onset of feedback presentation.
- Two event related potentials (ERPs) associated with feedback processing were evaluated, the feedback related negativity (FRN) and a fronto-central positivity (FCP).
- Spatiotemporal Principal Component Analysis was conducted

Result

Accuracy
- **Accuracy by Conditions (Consistent Vs. Inconsistent)**
  - Participants performed better under the consistent condition (M = 0.64, SD = 0.13) than the inconsistent condition (M = 0.57, SD = 0.1), $p \leq 0.001$.
- **Accuracy as a function of Age**
  - Accuracy in the consistent condition was found to be related to age, $R^2 = 0.047$, $p = 0.016$ with older participants performing better than younger participants. No significant relationship was found between age and accuracy in the inconsistent condition, $R^2 = 0.027$, $p = 0.073$

- **Accuracy and Working Memory**
  - Participants with better scores on a working memory measure (Number repetition) performed better under the consistent ($R^2 = 0.06$, $p = 0.011$) and inconsistent conditions ($R^2 = 0.06$, $p = 0.009$).
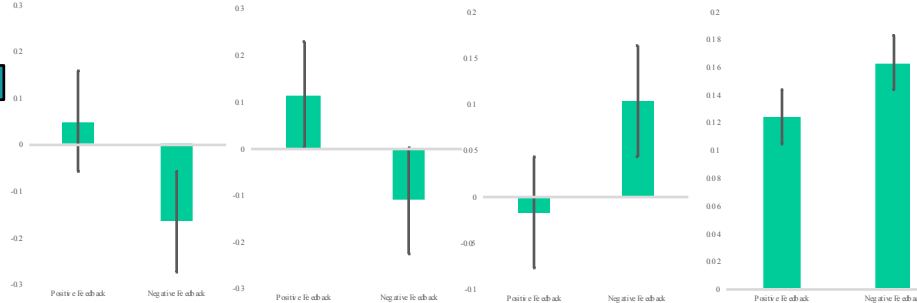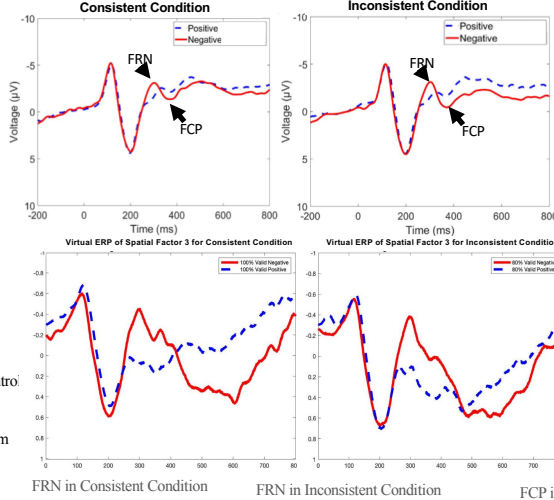- **Accuracy and Self-Efficacy**
  - No relationship was found between task accuracy and self-efficacy under the two conditions (consistent, inconsistent).
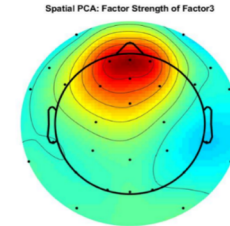
Self-Efficacy and Working Memory

Number Repetition vs Perceived Control
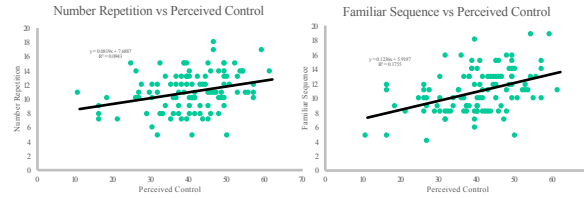
Familiar Sequence vs Perceived Control

- Working memory was found to be related to self-efficacy such that better working memory was associated with higher self-efficacy, Number Repetition vs Perceived Control: $R^2 = 0.10$, p = 0.001; Familiar Sequences vs Perceived Control: $R^2 = 0.15$, $p \leq 0.001$

Feedback Related ERPs

Consistent Condition

Inconsistent Condition

- **FRN**:
  - The FRN amplitude was larger (more negative) for negative feedback than for positive feedback ($p = 0.001$). No consistency effect was found.

- **FCP**:
  - The FCP amplitude was larger (more positive) under the inconsistent condition than the consistent condition ($p = 0.010$).

Virtual ERP of Spatial Factor 3 for Consistent Condition

Virtual ERP of Spatial Factor 3 for Inconsistent Condition

Spatial PCA: Factor Strength of Factor3

FRN in Consistent Condition

FRN in Inconsistent Condition

FCP in Consistent Condition

FCP in Inconsistent Condition

ERP and Accuracy
- **Consistent Condition**
  - Higher accuracy was associated with smaller FRN to positive feedback ($R^2 = 0.04$, $p = 0.02$) and larger FCP amplitude to positive ($R^2 = 0.08$, $p = 0.002$) and negative feedback ($R^2 = 0.04$, $p = 0.03$).
- **Inconsistent Condition**
  - No relationship was found between the FRN/FCP and accuracy.
- **Accuracy differences and ERP amplitude differences**
  - Accuracy differences between the consistent and inconsistent conditions were positively correlated with amplitude differences in FCP to negative feedback. Greater accuracy differences were associated with greater FCP differences ($R^2 = 0.04$, $p = 0.02$).

ERP and Working Memory
- **Consistent Condition**:
  Better verbal working memory scores were associated with smaller FRN amplitude to positive feedback ($R^2 = 0.04$, $p = 0.03$) and larger FCP amplitude to negative feedback ($R^2 = 0.04$, $p = 0.04$).
- **Inconsistent condition**:
  - No relationship between ERP components and working memory was found.

ERP and Self-Efficacy
- No relationship between the ERP components and self-efficacy was found in either consistent or inconsistent conditions.

Summary of Result

- Participants performed better under the consistent feedback condition.
- Older participants performed better than younger participants under the consistent condition, but not in the inconsistent condition.
- FRN was found to be larger (more negative) to negative than to positive feedback. However, the FRN did not differ between the two conditions (consistent, inconsistent)
- FCP was found larger (more positive) in the inconsistent condition than in the consistent condition.
- Participants whose accuracy was more affected by feedback inconsistency elicited larger FCP to negative feedback in the consistent condition than in the inconsistent condition.
- Under the consistent condition, participants who elicited smaller FRN to positive feedback, and larger FCP to positive and negative feedback, achieved higher accuracy.
- Working memory was found as a predictor of participants' task accuracy in both consistent and inconsistent conditions. Moreover, in the consistent condition, FCP to negative feedback and FRN to positive feedback were found correlated with one measure of WM (Familiar Sequences).
- Although self-efficacy was not found to be a predictor of task performance, it was found to be positively correlated with working memory.

Reference

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