Strategy Implementation & Feedback Processing in Healthy Young Adults

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Introduction

- Humans are thought to have two distinct learning systems, the **declarative** and the **non-declarative** learning system, and certain types of learning tasks are thought to engage one system over the other [2, 4, 5, 12, 13]
- The presence/absence of **feedback** during a learning task is one way that researchers can manipulate the engagement of the learning systems [8]
- Individual differences in learning can be viewed through **strategy analysis**, which has shown that some people take different approaches to learning, even under the same task conditions [5]
- Individual differences in learning can also be explored using EEG. The **Feedback-Related Negativity** (FRN) is an event-related potential that measures feedback processing [1, 7, 9]

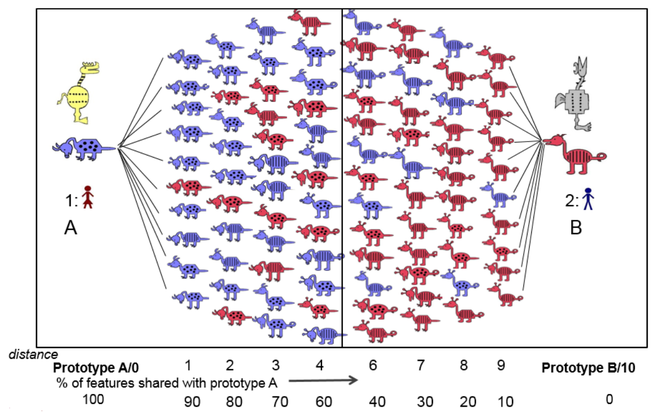
Primary Objective

To explore the relationship between the learning systems, the strategies employed during learning, and the processing of feedback.

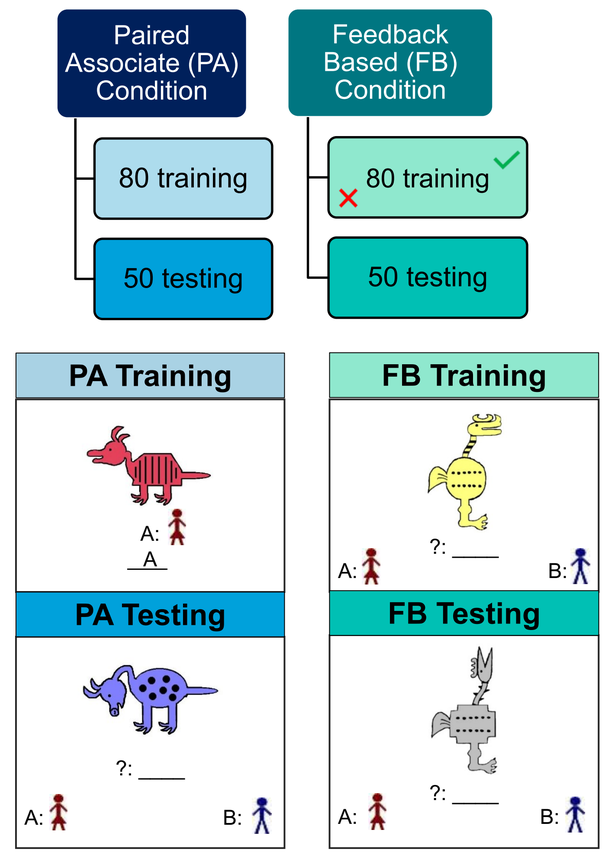
Methods

Participants	*n* / M, SD
Gender	25 F, 10 M *
Age	25 years, ± 3.33 *

** Missing gender and age information for 3 participants*



An Electrical Geodesics Inc. system and a 32-channel HydroCel Geodesic sensor net were utilized. EEG was sampled at a rate of 1000 Hz and filtered using a 0.1-30 Hz bandpass. Data were segmented into epochs from 200msec before feedback to 800msec after feedback. Independent Component Analysis (ICA) was completed to remove noise and movement artifacts. [1]



Measures

Accuracy

$$\frac{\#\ correct\ responses}{\#\ test\ items} \times 100$$

Strategy

$$\frac{\sum_F (\#B\_expected_{F,M} - \#B\_actual_F)^2}{\sum_F (\#Bpresentations_F)^2}$$

~30/70, 20/80	Optimal Multi-Cue

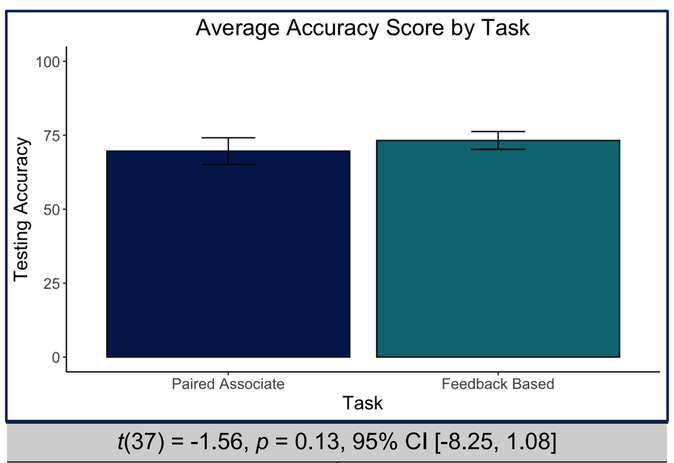
~10/90	Single Feature

~50/50	Random Pattern

FRN Amplitude

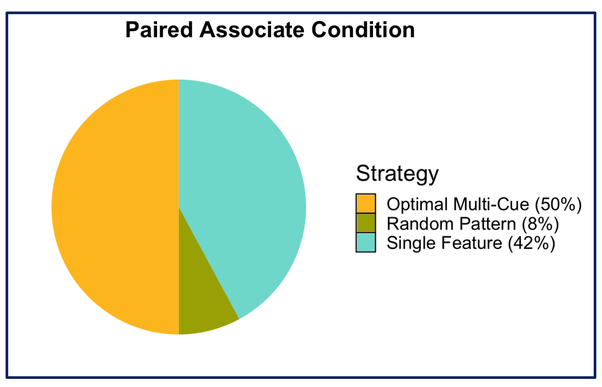
Event Related Potentials from the frontocentral recording site, FCz, were subjected to a temporal principal component analysis (TPCA) [1]

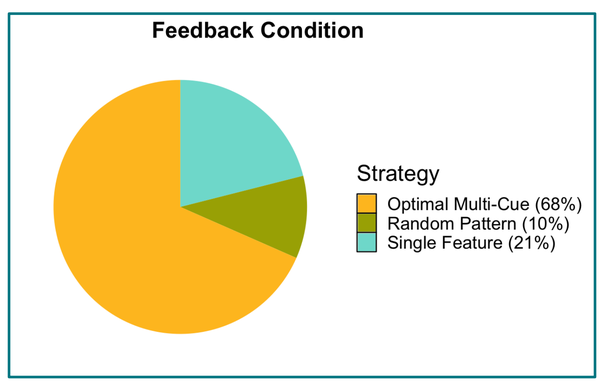
Results

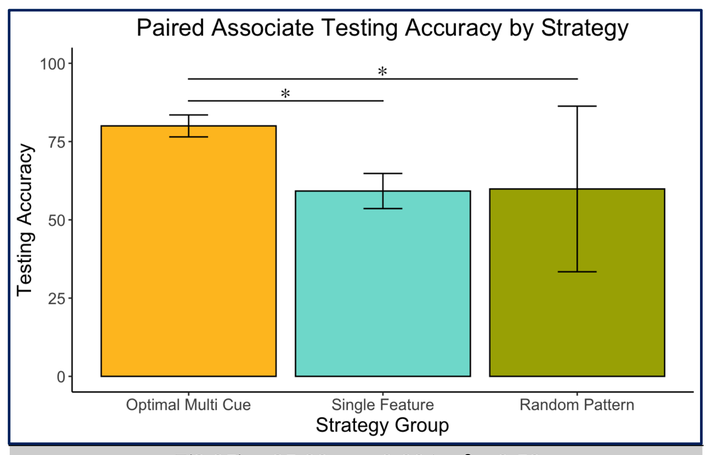


t(37) = -1.56, *p* = 0.13, 95% CI [-8.25, 1.08]

Paired Associate Condition	Feedback Condition
M = 69.65, *SD* = 13.67	*M* = 73.23, *SD* = 9.17

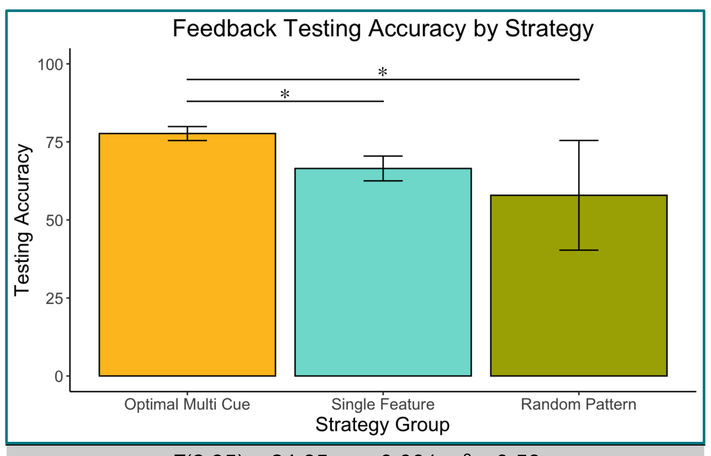






F(2,35) = 25.09, *p* < 0.001, η^2 = 0.59

Optimal Multi-Cue	*M* = 80.0, *SD* = 6.72
Single Feature	*M* = 59.20, *SD* = 8.93
Random Pattern	*M* = 59.86, *SD* = 15.02

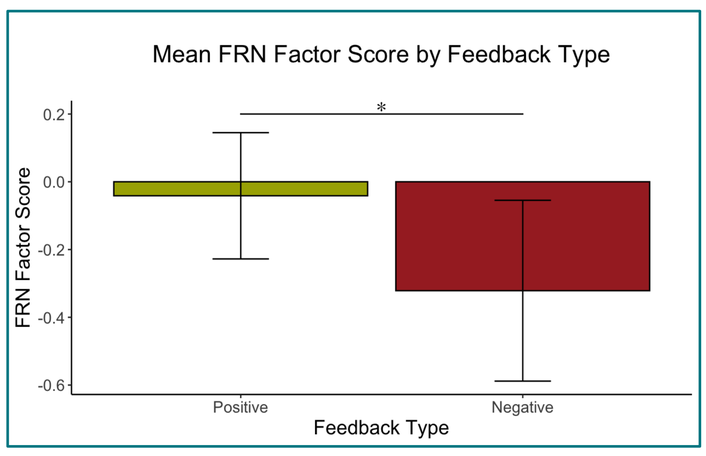


F(2,35) = 24.65, *p* < 0.001, η^2 = 0.58

Optimal Multi-Cue	*M* = 77.68, *SD* = 5.54
Single Feature	*M* = 66.48, *SD* = 4.74
Random Pattern	*M* = 57.89, *SD* = 11.05

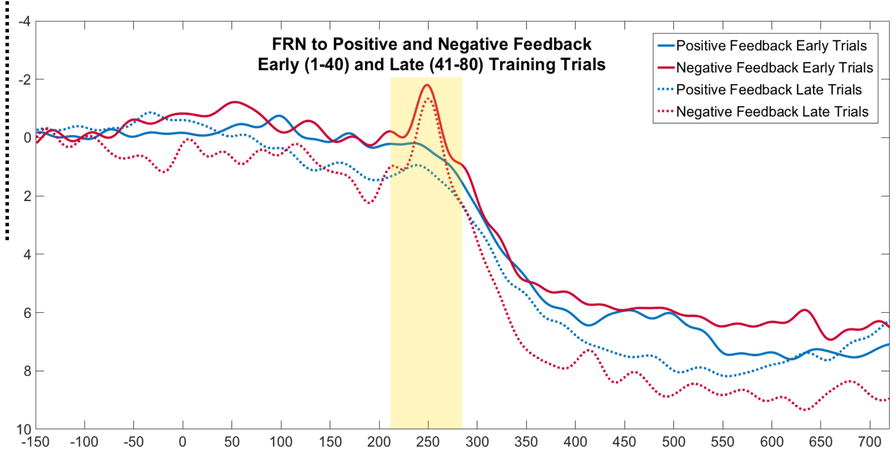
FRN Factor Score, 2 x 2 x 3 ANOVA Table

Predictor	df_{Num}	df_{Den}	SS_{Num}	SS_{Den}	*F*	*p*	η^2_g
Strategy	2	34	0.24	65.89	0.06	.939	.00
Time	1	34	0.43	23.23	0.63	.434	.00
Feedback Type	**1**	**34**	**3.97**	**29.70**	**4.54**	**.040***	**.03**
Strategy x Time	*2*	*34*	*4.38*	*23.23*	*3.21*	*.053*	*.03*
Strategy x Feedback Type	2	34	2.91	29.70	1.66	.205	.02
Time x Feedback Type	1	34	0.51	16.16	1.07	.307	.00
Strategy x Time x Feedback Type	2	34	1.50	16.16	1.58	.222	.01



F(1,34) = 4.54, *p* = 0.04, *d* = 0.28, 95% CI [-0.04, 0.61]

Positive
M = - 0.04, *SD* = 0.80
Negative
M = - 0.32 , *SD* = 1.15



Discussion

- Healthy young adults achieved similar accuracy scores between the paired associated (non-feedback) and feedback-based tasks.
- A larger majority of healthy young adults employed an optimal multi-cue strategy under the feedback-based condition than on the paired associate condition.
- Those who employed an optimal multi-cue strategy, regardless of task condition, significantly outperformed those who employed single feature and random pattern strategies. Accuracy scores between single feature and random pattern strategy users were not significantly different.
- There was a significant main effect of feedback type on FRN amplitude. Feedback type was associated with a small effect (*d* = 0.28) on FRN amplitude.
- The interaction between strategy and time, while not significant at the *p* < 0.05 level, revealed a significant difference in factor scores between early and late training in the single feature strategy group *only,* which was associated with a large effect, *d* = -1.08, 95% CI [-1.81, -0.32].

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