



Why are Some People More Creative Than Others? An Electrophysiological Approach

Kristina Pfeifer & Mark W. Geisler
San Francisco State University



The Present Research

The aim of the current study was to use electroencephalography as a method to investigate associative processing within creative individuals.

Introduction

Associative Processing

- In 1962 Mednick⁶ proposed an idea of how creative ideas are formed and why creative individuals are better at producing original ideas. This theory assumed that reaching and merging uncommon associates helps form creative ideas. Building on this, he assumed that creative people have more remote information stored within semantic memory. This unique spread of information allows them to easily think outwardly and originally when solving a creative problem.
- Previous studies have found that creative individuals produce more uncommon responses on word association tasks,^{1,7} and can make more connections between remote concepts.^{2,10} However, other studies suggest that these results are inconsistent. For example uncommon responses may be a product of increased response fluency resulting in uncommon responses to happen later on.³

Event-Related Potentials

- Larger N400 amplitude may be interpreted as greater effort to establish connections between distantly related concepts stored within semantic memory.⁵
- According to Rutter et al. (2012) sustained negativity following the N400 marks the ongoing difficulty of integrating information between remote concepts.¹¹
- Previous research on conceptual expansion has suggested that less sustained negativity occurs after successfully establishing a new association between remote concepts. The N400 however, may only be sensitive to the unusualness of the stimuli and not integrating new information.^{8,11}

Participants

Participants (N = 31, 11 Male) were students at San Francisco State University who were right handed, had normal, to corrected-normal vision, no history of head trauma, and their primary language was English.

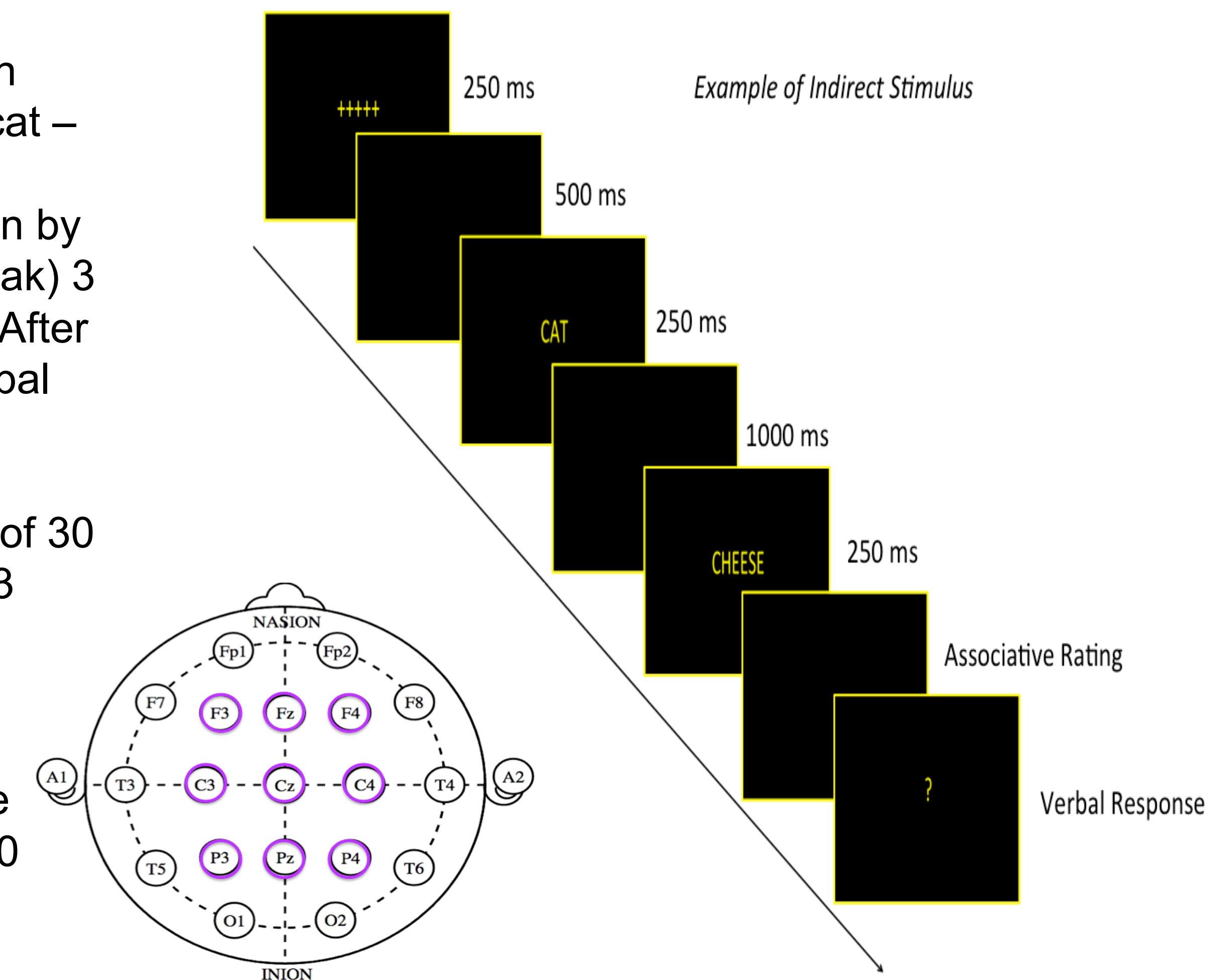
Methods

Stimulus Presentation

- Participants were asked to try and form an association between related (rabbit – carrot), indirectly related (cat – cheese), and unrelated (nail – phone) word pairs. Participants then rated the strength of the association by pressing with their left hand 1 (no association) 2 (weak) 3 (moderate) or 4 (strong) association on a keyboard. After rating, participants verbalized their response. All verbal responses were recorded through an iPhone set in airplane mode.
- Word pairs were pseudo randomized and consisted of 30 trials per condition for a total of 90 trials (divided by 3 blocks).

ERP Recordings

- EEG Data was recorded after the presentation of the last word, and was divided into 1000 ms epochs (100 ms baseline). Analyses focused on the N400 (400–600 ms) and Sustained Negativity (600-900 ms).



Creative Groups

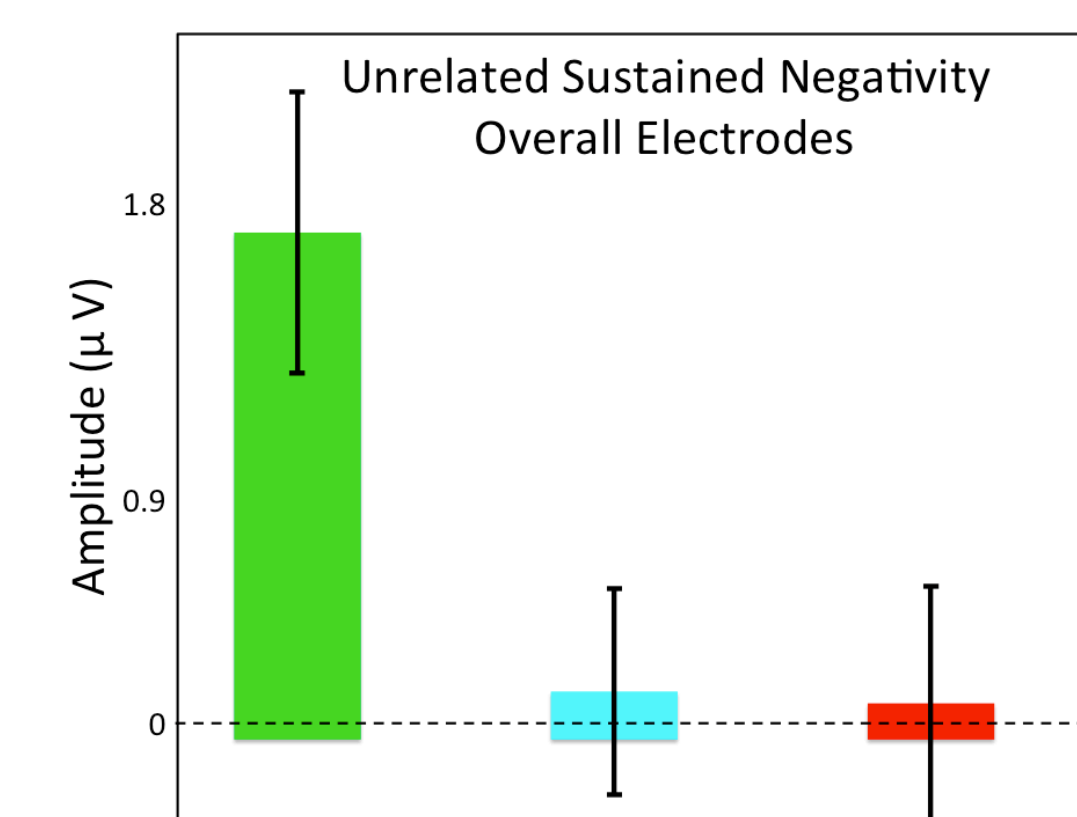
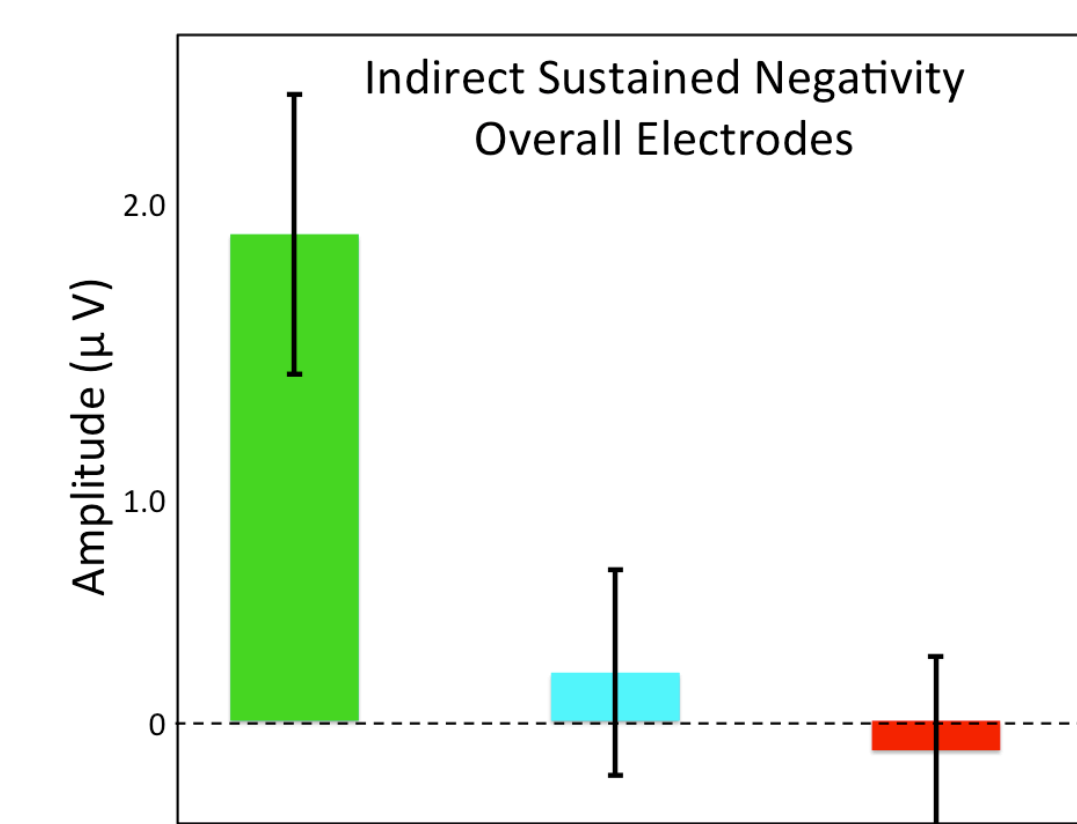
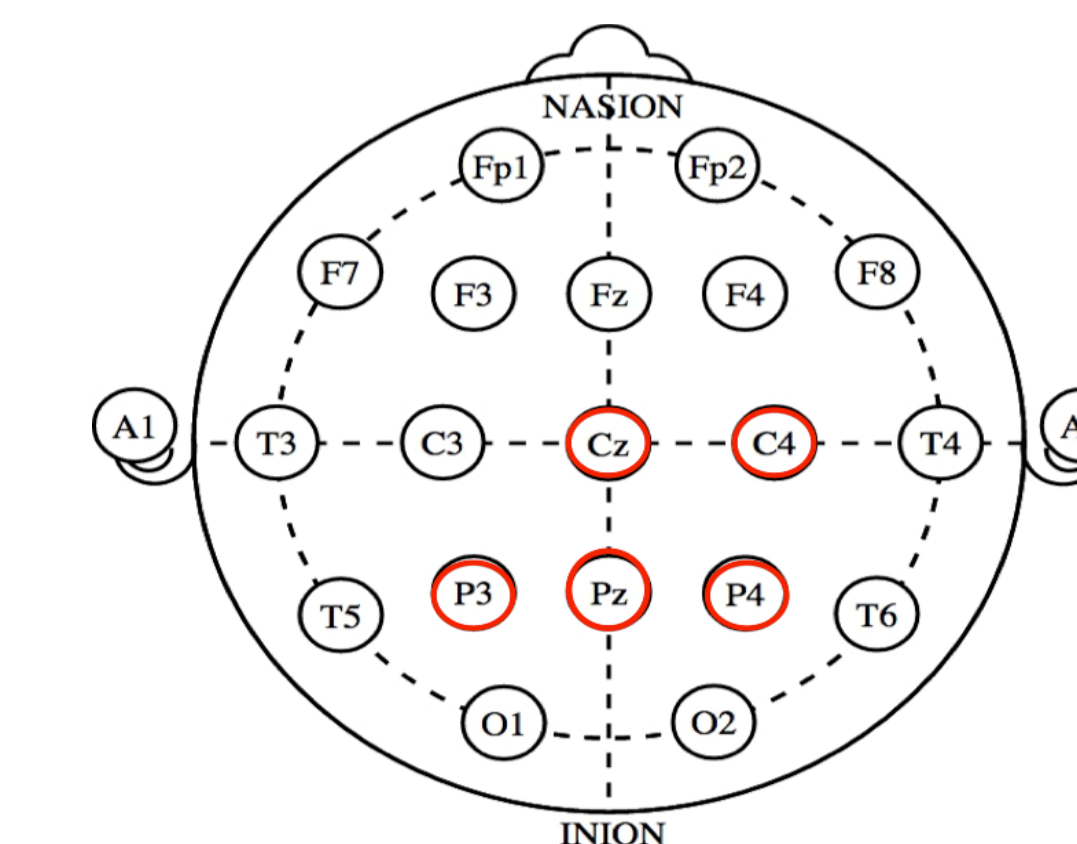
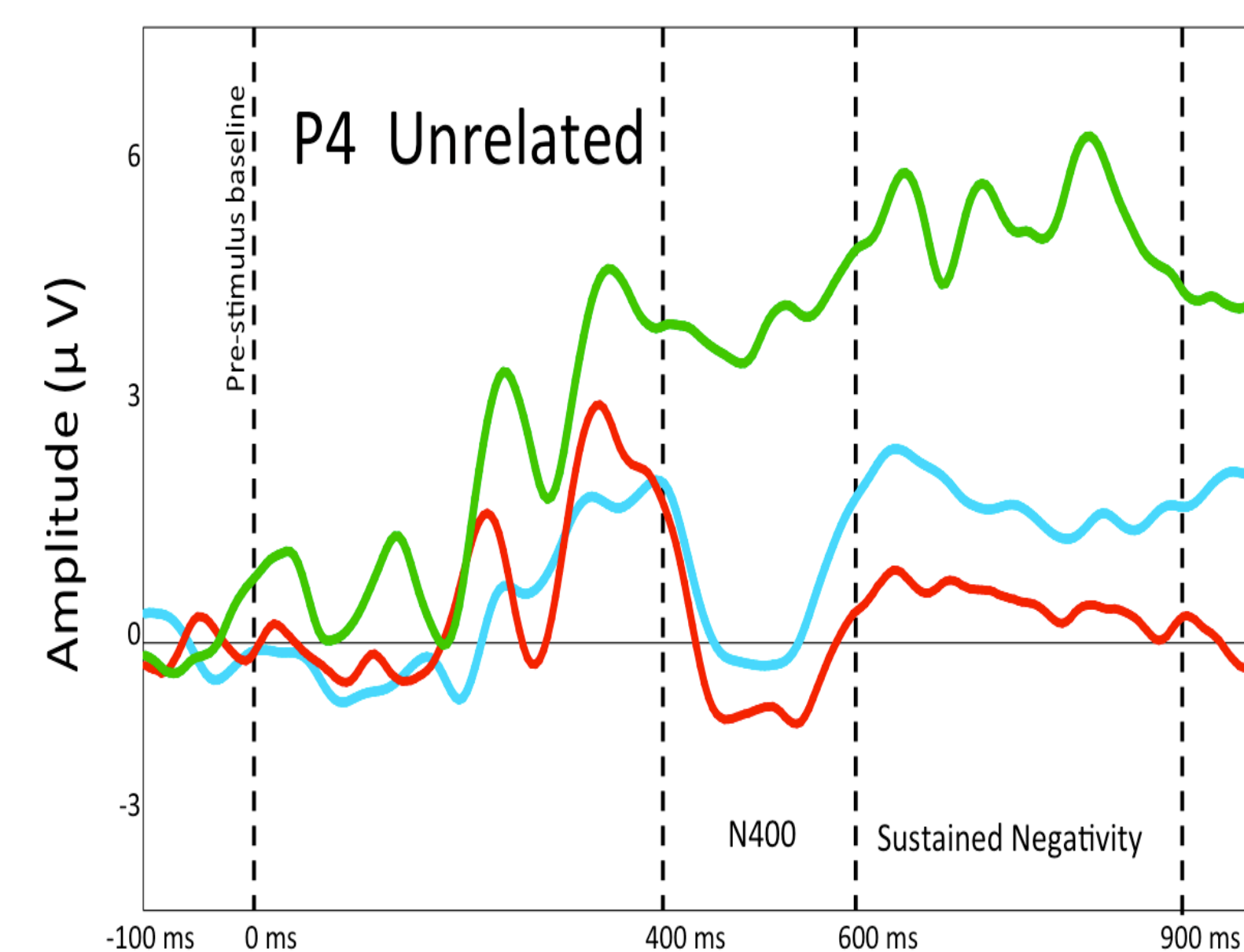
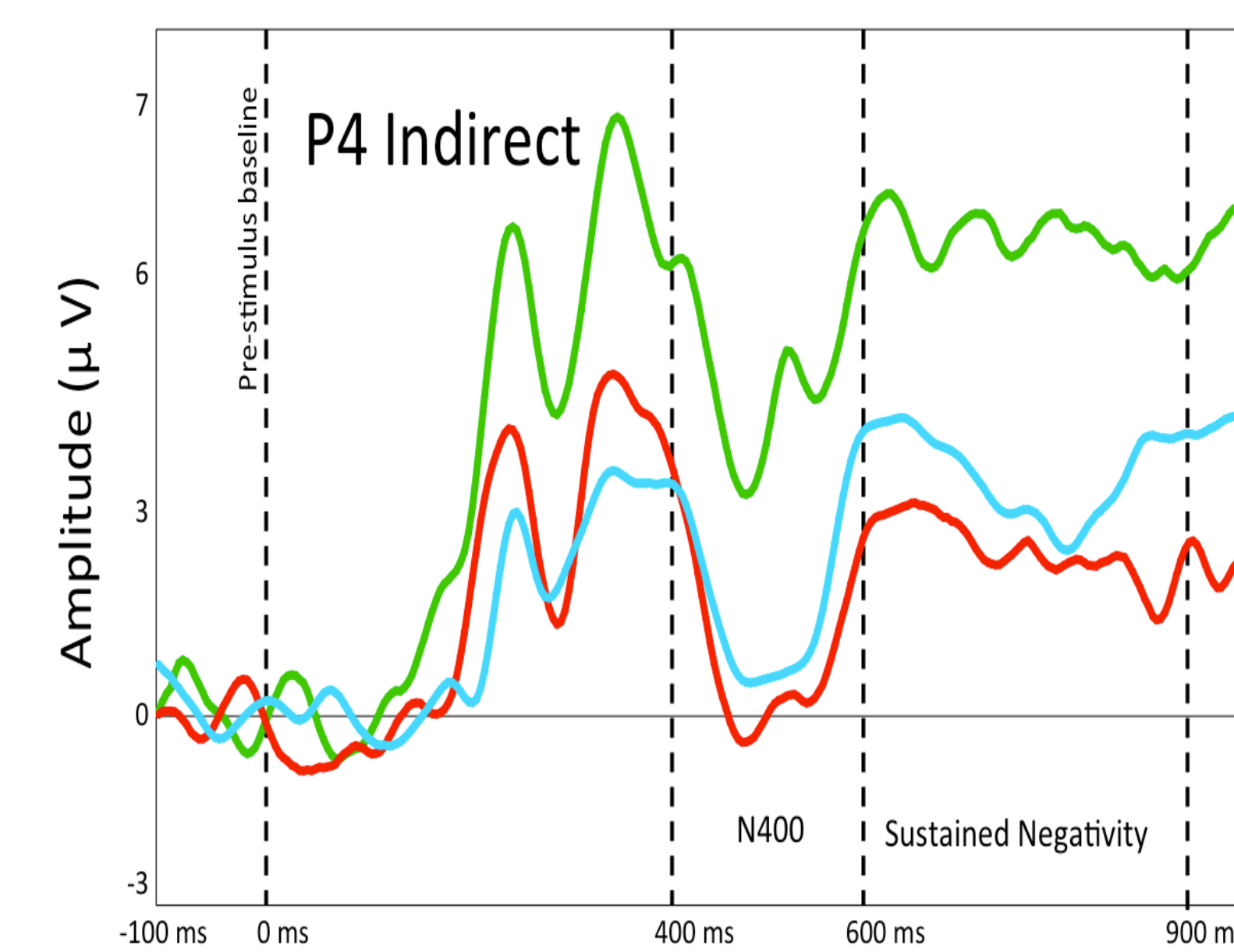
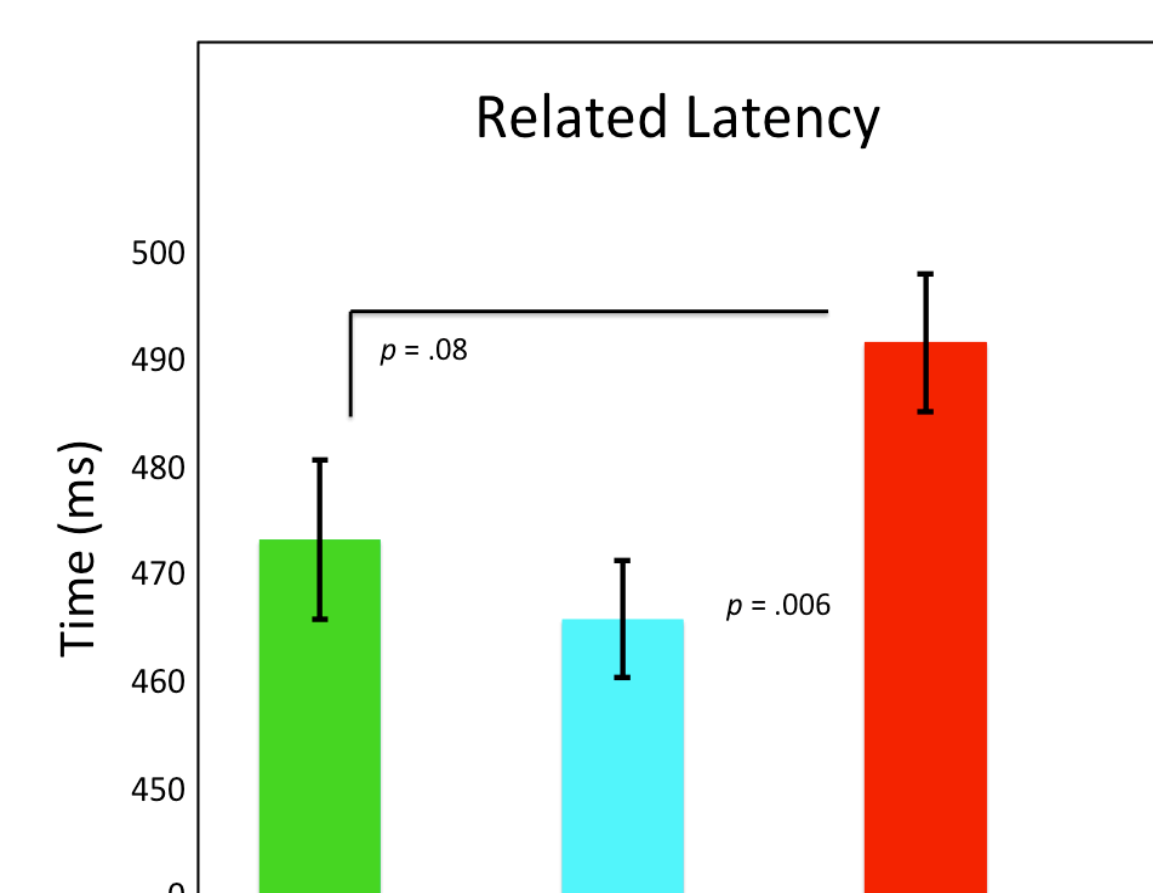
Creativity was measured using a classic divergent thinking measure called the alternative uses task. Those who scored 1-2.3 were considered uncreative (n = 11), 2.31-3.6 were moderately creative (n = 13) and 3.61-5 were considered creative (n = 7).

Results

- A 9 electrode (Fz, Cz, Pz, F3, F4, C3, C4, P3, P4) x 3 condition (related x indirect x unrelated) x 3 group (creative x moderate x uncreative) repeated measures ANOVA was run on N400 latency, amplitude and sustained negativity.
- N400 Latency:** For the related condition, over all electrode sites, moderately creative people had significantly smaller latencies ($M = .452, S.E = .011$) compared to uncreative individuals ($M = .504, S.E = .13$), $t(29) = -3.0, p = .006$. In addition, creative people had trending smaller latencies ($M = .467, S.E = .015$) compared to uncreative individuals $t(29) = -1.8, p = .08$.
- N400 Amplitude:** We found a trending significant effect of electrode site by condition by group ($p = .052$). For the indirectly related condition at electrode site P3 and P4, creative people had significantly smaller N400 amplitudes compared to uncreative individuals (all $p < .05$). In addition, creative people had significantly smaller N400 amplitudes for the unrelated condition at electrode sites Cz, Pz, C4, P3, and P4 compared to moderate and uncreative individuals (all $p < .05$).
- Sustained Negativity:** No significant differences were seen for group by condition ($p = .186$). However, the general means are going in the direction we predicted for both indirect (creative = 1.943 > moderate = .192 > uncreative = -.118) and unrelated conditions (creative = 1.61 > moderate = .152 > uncreative = .115).

Results

Groups	Indirect Response Fluency	Indirect Associative Strength	Unrelated Response Fluency	Unrelated Associative Strength
Uncreative	21.3	2.8	10.9	1.8
Moderate	22.7	2.9	10.8	1.7
Creative	25.1	3.3	17.42	2.4



Discussion

The N400 is particularly sensitive to semantic violations.⁵ Creative individuals had smaller N400 amplitudes in the central and parietal areas for indirectly related and unrelated word pairs. These areas of the brain are typically where semantic information is processed and where the N400 shows its maximum effect.⁵ We provide preliminary results suggesting that creative brains do not respond as strongly to the unusualness of a distantly related or unrelated word pairs. This may indicate a unique spread of associative information stored within these people brains.