The consequences of extending vs. mixing metaphors: An ERP study

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Introduction

- Metaphors are pervasive in everyday language [1]
- They are often used to describe abstract concepts in a more concrete and vivid way
- On the one hand, widespread use of **extended metaphors** (a) suggests it is advantageous to activate literal conceptual content when interpreting metaphoric language
- Conversely, spontaneous use of **mixed metaphors** (b) suggests that literal content may be "dead" (suppressed) for conventional metaphors [e.g., 2]

  a. *With the stock market **sinking** so fast, Wall Street is going to need a **scubatank** to survive!*

  b. *With the stock market **sinking** so fast, Wall Street is going to need a **parachute** to survive!*

Research Questions

- Are conceptual mappings in conventional metaphors productive?
- Is there an online comprehension benefit for maintaining metaphoric consistency over switching metaphors mid-stream?

Example Metaphor Stimulus Set

Story Background

A. Conventional Metaphor: DEPRECIATION IS SINKING

The NASDAQ sank 22 percent last year. The DOW plunged even further down. Experts have been saying that this can't go on much longer.

B. Conventional Metaphor: DEPRECIATION IS FALLING

The NASDAQ fell 22 percent last year. The DOW plummeted even further down. Experts have been saying that this can't go on much longer.

C. Literal Description

The NASDAQ decreased by 22 percent last year. The DOW was devalued even further. Experts have been saying that this can't go on much longer.

Story Target Sentence (extended metaphor)

Wall Street is going to need a _____ to survive.

1. *scubatank*
2. *parachute*

Example Filler Stimulus Set

Story Background

Seven prisoners escaped from the penitentiary late last night. Guards discovered their empty cells just before sunrise.

Story Target Sentence

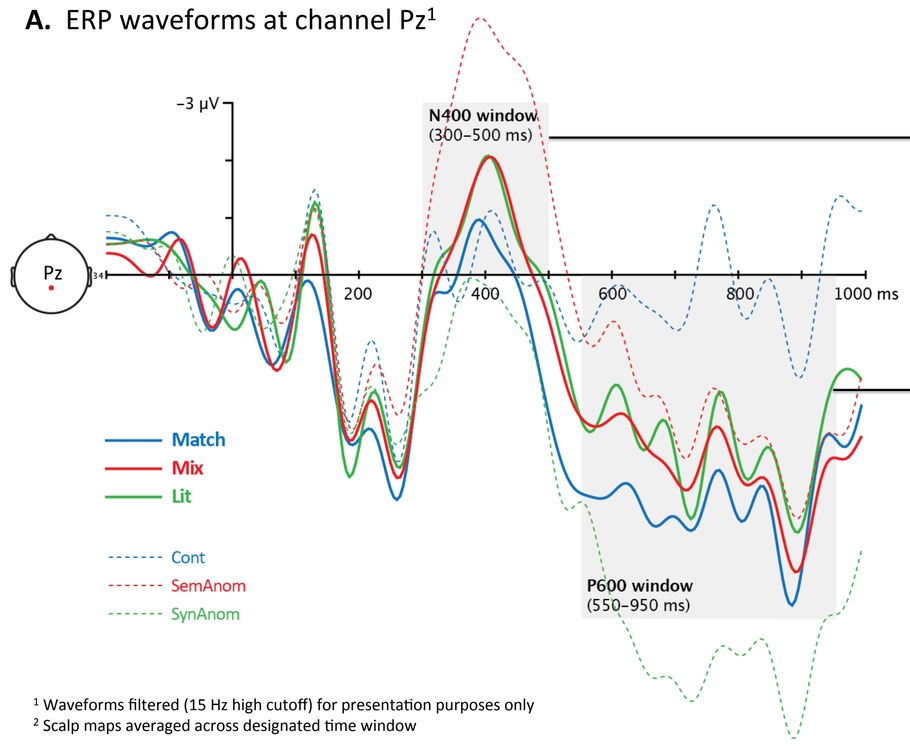
The prisoners were halfway across the state before the warden finally _____ for assistance.

Control *called*
Sem Anom *licked*
SynAnom *calld*

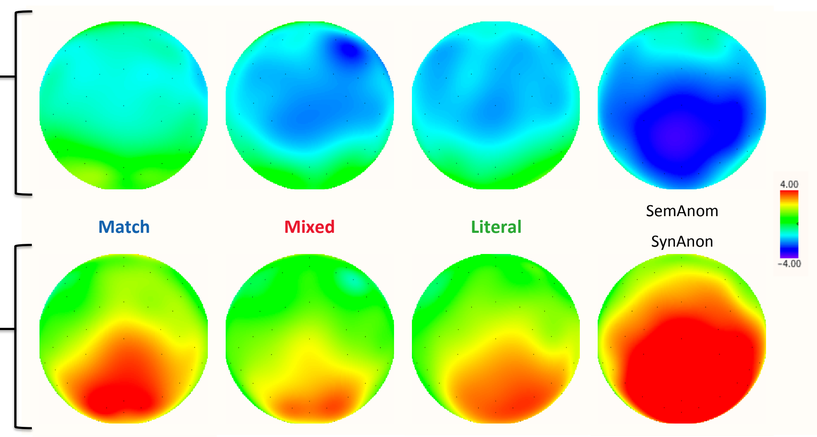
Preliminary Results and Discussion

Grand Average ERPs

A. ERP waveforms at channel Pz[1]



B. Scalp distribution of ERP voltages[2]

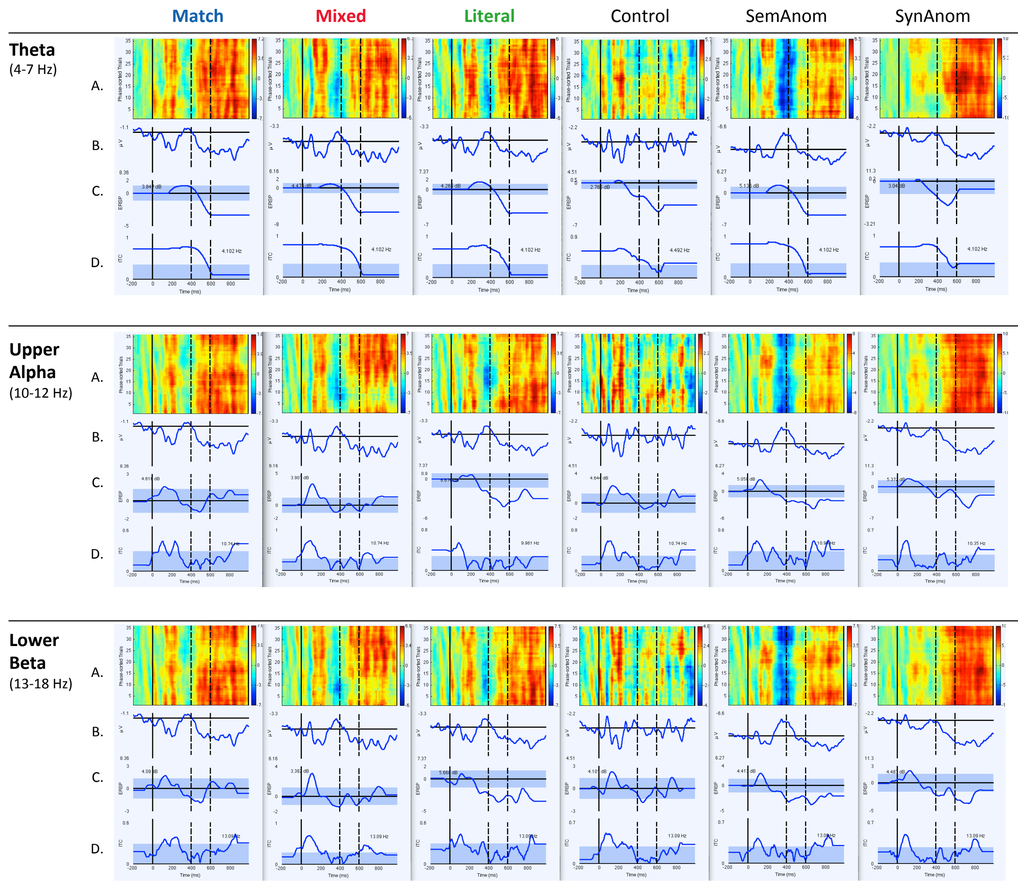


N400s for Mixed and Literal were significantly more negative than Match (*ps*<.05), which suggests they required more semantic effort to process. However, neither Mixed nor Literal elicited a classic N400 effect, suggesting that their metaphorical meanings were accessed.

All metaphorical conditions elicited a P600 relative to Control with no reliable differences between metaphor conditions (*ps*=n.s.). However, the amplitude was significantly smaller than a classic P600 effect (*p*<.001), suggesting that metaphorical target words required additional analysis but were integrated into a message-level representation [cf., 3].

[1] Waveforms filtered (15 Hz high cutoff) for presentation purposes only
[2] Scalp maps averaged across designated time window

Joint Time-Frequency Analysis



Theta (4-7 Hz)

Prior Evidence: Theta band event-related synchronization (ERS) has been linked to memory retrieval operations [4,5,6]. It has also been suggested that theta band activity may index the incremental construction of a working memory trace of the linguistic input [6].

Findings:
- All conditions showed event-related desynchronization (ERD) during N400 window
- While metaphorical conditions and SemAnom remained desynchronized, Control and SynAnom resynchronized during P600 window

Upper Alpha (10-12 Hz)

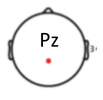
Prior Evidence: Early upper alpha band ERS has been linked to lexical retrieval [7,8,9]. Decreases in power during N400 window have been implicated in semantic processing [4,8,7].

Findings:
- All conditions showed alpha resynchronization following word onset
- Early alpha power increased for Mixed, Control, and SemAnom
- Literal, SemAnom, and SynAnom showed late alpha power reduction (but with differing profiles)

Lower Beta (13-18 Hz)

Prior Evidence: Lower beta ERS linked to semantic-pragmatic analysis [10]. Decreasing beta power possibly related to unification difficulty [11].

Findings:
- All conditions except Control showed increasing beta resynchronization from ~400 ms to onset of subsequent word (600 ms)
- Lit, SemAnom, and SynAnom showed long-lasting decrease in beta power beginning in N400 window



A. Phase-sorted ERP images. Each horizontal line represents an individual subject's ERP, color-coded to indicate potential (uV) at each time point. A 3-cycle wavelet at the specified frequency was applied to windows centered at time 0 ms for each subject, sorting them by their EEG phase value. A 10-subject smoothing was applied to make phase coherence between adjacent subjects more apparent).

B. Grand average ERP waveforms.

C. Event Related Spectral Power. Mean changes in power (dB) across epochs. Blue region indicates 5% confidence limits according to surrogate data drawn from random windows in baseline.

D. Coherence across subjects. Degree of phase synchronization relative to stimulus presentation. A value of 1 indicates that phase (in this latency window) is constant for every subject. A value of 0 occurs when the phase values for all subjects are uniformly distributed.

Behavioral Results

Condition	Sensicality Judgment		Sensicality Response Time		Comp. Question Accuracy	
Match	85.8 %	***	602 ms	*	96.1 %	n.s.
Mixed	68.4 %		690 ms		97.1 %	
Literal	71.3 %		662 ms		95.1 %	
Control	99.8 %	***	479.1 ms	***	93.1 %	n.s.
SemAnom	09.1 %		1048.0 ms		---	
SynAnon	95.8 %		498.9 ms		96.1 %	

Methods

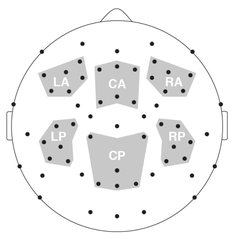
Participants
- 36 right-handed, native speakers of American English (17 male, 19 female)
- Mean age: 20.6 (range 18 to 22)

Stimuli – 108 short stories

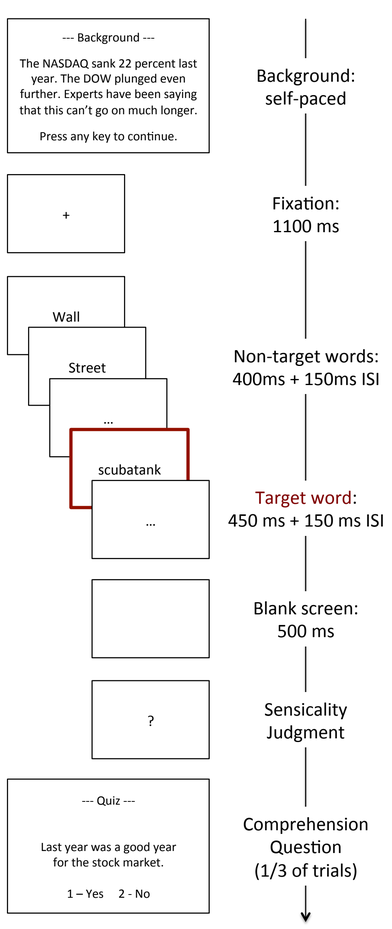
36 Metaphorical	72 Filler Items
Match (A→1, B→2)	Semantic Anomaly
Mixed (B→1, A→2)	Syntactic Anomaly
Literal (C→1, C→2)	Filler Control

Dual Task
- Sensicality judgment following each story
- Yes/No comprehension quiz following 1/3 of stories

EEG Recording
- 64-channel HydroCel Geodesic Sensor Net (EGI)
- Bandpass: 0.1-40 Hz; downsample: 200 Hz; rereference: avg. mastiods
- Voltages averaged for analysis within six 6-channel groups



Procedure



Conclusions

The comprehension of extended metaphors is facilitated by first reading conceptually related conventional metaphors
- Therefore, conceptual mappings in conventional metaphors can be productive

There are different consequences for mixing metaphors than for using an extended metaphor without prior contextual support (i.e., Literal condition)
- Mixed condition required more cognitive effort during lexical retrieval
- Literal condition was more taxing during the (post-lexical access) semantic processing and message-level unification period

Overall, these findings suggest that metaphor productivity provides a communicative advantage (replicating and extending [12])
- Metaphoric categories may function as a conceptual alphabet
- Existing structural mappings can be extended on the fly
- Allows speaker to convey large amount of information with minimal effort

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Next Steps

- By-items ERP analysis
- Assess correlation of ERPs with off-line ratings of aptness, fit, comprehensibility, conventionality, metaphoricity

Acknowledgments

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