

Semantic and Social Prediction and Its Effects on Memory

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Background: Semantic and Theory of Mind (ToM) processing are rarely studied together, yet emerging evidence suggests they may share underlying cognitive and neural mechanisms [1]. In this within-subject EEG study, we used event-related potentials (ERPs) and time–frequency analyses (TFA) to examine whether predictive coding and prediction error rely on similar neural processes across semantic and ToM domains, and whether prediction error modulates subsequent memory formation. Specifically, the current study addressed the following questions: 1) Do semantic and ToM processing share neurocomputational mechanisms supporting prediction and prediction error? 2) Does prediction error influence subsequent memory performance and enhance memory for the incongruent words?

Method: Thirty native English speakers completed an EEG sentence-reading task in semantic and ToM domains across two sessions, in which sentence contextual constraint (high vs. low) and target word congruency (congruent vs. incongruent) were manipulated (Table 1). Each EEG session was followed 24 hours later by word recognition.

Result: TFA revealed that, across both domains, prediction error elicited alpha-beta desynchronization and theta synchronization (Figure 1a), which potentially reflect the activation of task-relevant information and representation updating, respectively [2-4]. Cluster-based permutation test on ERPs shows that prediction elicited similar N400 effects (Figure 2), alongside alpha–beta effects that shared the spatial distribution but differed in timing and direction (Figure 1b), characterized by power decreases in the semantic domain and power increases in the ToM domain.

Memory performance showed better recognition for congruent than incongruent words in the semantic domain, but the opposite pattern in the ToM domain (Figure 3a). The semantic effect was contrary to our prediction but consistent with the schema-based account [5]. Importantly, N400 prediction-error effects predicted recognition performance in the semantic domain (Figure 3b), suggesting that prediction-error effects on memory remained present, but potentially in a more implicit form.

Conclusion: Both prediction and prediction error may be supported by shared neural mechanisms across the semantic and ToM domains. Prediction error enhances memory for incongruent information and predicts subsequent memory.

References

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Figures and Tables

Table 1: Example Stimuli from Both Domains

Domain	Constraint	Context	Congruent	Incongruent	Ending Words
Semantic	HC	He does stand-up performances in clubs, telling jokes and funny stories. He makes his living as...	a comedian	an economist	in the city
	LC	He does his work in a variety of places these days. He makes his living as...	a comedian	/	
ToM	HC	Lucia's mum prepared an eggplant for dinner. Lucia hated its bitterness and replaced it with a carrot. When her mum came back, she expected to find...	an eggplant	a carrot	on the table
	LC	Lucia's mum prepared something for dinner. Lucia hated it and replaced it with something else. When her mum came back, she expected to find...	an eggplant	/	

Figure 2. ERP and scalp topographies of significant clusters associated with prediction error and prediction effects across domains

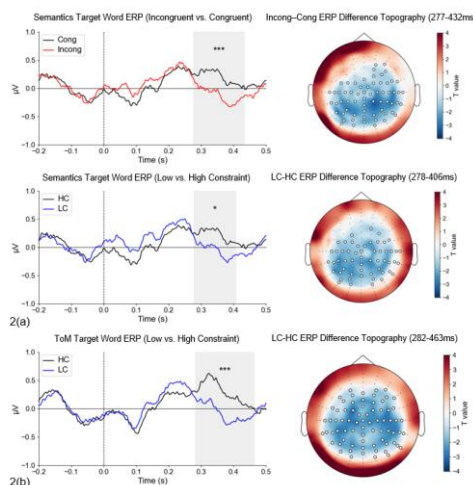


Figure 1. Time–frequency representations and scalp topographies of significant clusters associated with prediction error and prediction effects across Semantic and ToM domains.

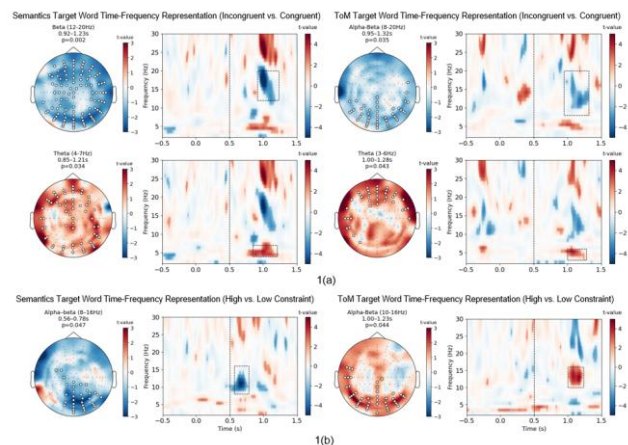


Figure 3. GLMM results for word recognition accuracy and ERP–accuracy correlations.