Positive mood, broader connections: N400 amplitudes reveal mood-sensitive spreading activation in bilinguals

Piotr Żukowski[1], *Marcin Naranowicz*[1]

[1] *Adam Mickiewicz University of Poznan, Poland*

Background: Mood, defined as a background affective state, incessantly filters through our thoughts, decisions, and actions [1]. Research has indicated that positive and negative moods distinctively modulate cognitive mechanisms, with positive and negative moods respectively facilitating assimilative and accommodative thinking [1]. In monolingual research, a positive mood has been found to facilitate the processing of unexpected and distantly related semantic information (e.g., [2]; [3]). More recently, mood has been reported to modulate meaning integration differently in the first (L1) and foreign (L2) languages, pointing to inhibition of full meaning integration in L2 [4].

Method: Although previous research indicates that positive and negative affect can differentially shape semantic integration and re-analysis in L1 and L2, it remained unclear how mood shapes spreading activation in semantic memory in bilinguals. To this end, 32 highly proficient Polish–English (L1–L2) bilinguals underwent positive and negative mood inductions using thirty-two emotionally potent 45-second films [5] administered in two separate mood blocks. Participants were presented with pre-validated sets of 240 Polish and 240 English prime–target pairs representing three degrees of semantic relatedness: closely related (e.g., interpreter–translator), weakly related (e.g., researcher–translator), and unrelated (e.g., brake–translator), and made semantic relatedness judgements. To control for variability in semantic relatedness, we supplemented human relatedness ratings with semantic vector scores for each word pair, obtained from a word-embedding model trained on a large corpus. Cosine similarity between prime and target vectors was used as an approximation of their semantic distance. Human ratings and vector-based similarity showed a strong positive correlation (r = .82, p < .001).

Results: The analysis of N400 amplitudes (i.e., an event-related potential component indexing lexico-semantic processing) revealed a Mood × Word pair interaction for Polish (L1) stimuli. In both mood blocks, closely related pairs elicited reduced N400 amplitudes relative to the remaining pair types (ps < .001). Crucially, in a negative mood, unrelated pairs elicited larger N400 amplitudes than weakly related pairs, whereas in a positive mood these two conditions did not differ (p = .142). Additionally, unrelated pairs elicited decreased N400 amplitudes in a positive relative to a negative mood (p = .018; see **Figure 1**). For English (L2) stimuli, only a graded fixed effect of Word pair was observed: unrelated pairs yielded larger N400 amplitudes than weakly related pairs (p < .001) and closely related pairs (p < .001), while weakly related pairs elicited larger N400 amplitudes than closely related pairs (p < .001; see **Figure 2**). Moreover, mean N400 amplitudes correlated negatively with both semantic relatedness (r = .35, p < .001) and semantic vectors (r = .32, p < .001), such that both increased semantic relatedness ratings and semantic vectors were accompanied by decreased mean N400 amplitudes across all conditions.

Discussion: Our results align with earlier monolingual research in indicating that a positive mood facilitates lexico-semantic processing in L1 (e.g., [2]; [6]). In particular, the mood-related decrease in neurocognitive resources devoted to lexico-semantic access for unrelated pairs in L1 implies that a positive mood may foster assimilative processing and increase spreading activation in L1 semantic memory, enabling more extensive semantic connections. By contrast, the absence of mood-driven modulation in L2 neural responses suggests that L2 comprehension may remain insensitive to mood fluctuations, which is consistent with accounts of emotional detachment in L2 [4]. Moreover, the strong agreement between semantic vectors and human-rated semantic relatedness suggests that distributional semantic metrics can effectively approximate human semantic judgements in psycholinguistic research (see [7]; [8]). Notably, the similarity in correlations with mean N400 amplitudes suggests that vector-based metrics can perform on par with human ratings as measures of semantic relatedness in electrophysiological research.

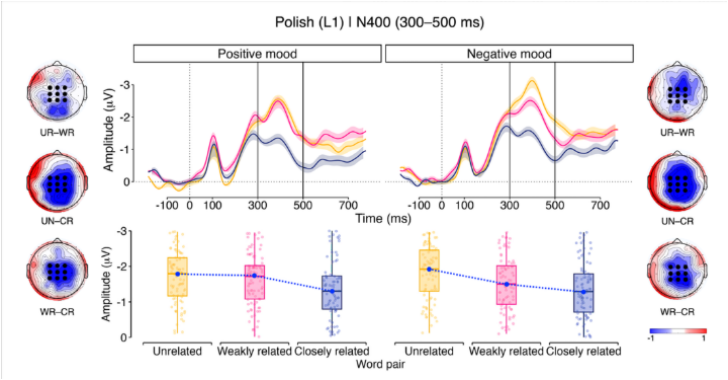

Figure 1: A visual representation of the Mood × Word pair interaction for Polish (L1) prime–target pairs in the N400 time window (300–500 ms). The shaded areas represent 95% confidence intervals. The waveforms (the top panel) represent brain potential variations over fronto-central (FC1, FCz, FC2), central (C1, Cz, C2), and centro-parietal (CP1, CPz, CP2) electrodes. The topographic maps (the outer left and right panels) represent differences in the N400 amplitudes between the respective word pair types in the 300–500 ms time window. The boxplots (the bottom panel) represent distribution of N400 responses to individual Polish (L1) prime–target pairs.

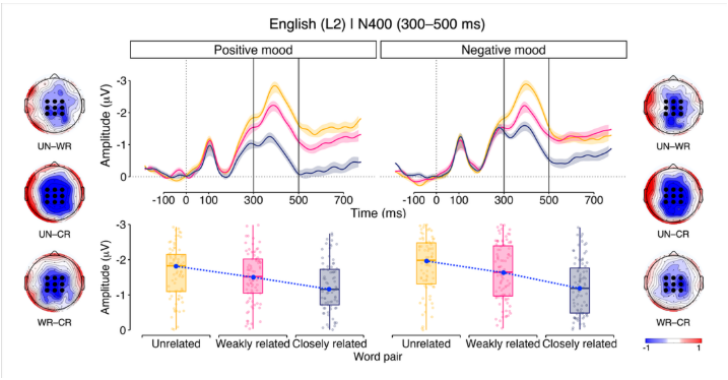

Figure 2: A visual representation of a fixed effect of Word pair split by both mood types for English (L2) prime–target pairs in the N400 time window (300–500 ms). The shaded areas represent 95% confidence intervals. The waveforms (the top panel) represent brain potential variations over fronto-central (FC1, FCz, FC2), central (C1, Cz, C2), and centro-parietal (CP1, CPz, CP2) electrodes. The topographic maps (the outer left and right panels) represent differences in the N400 amplitudes between the respective word pair types in the 300–500 ms time window. The boxplots (the bottom panel) represent distribution of N400 responses to individual English (L2) prime–target pairs.

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