ERP Indices of Pragmatic Language Processing

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Research on implicature processing has mainly centered on *scalar* implicatures, observing different effects, not unique to pragmatics [1, 2, 3]. Relatively little is known, however, about the processing of implicatures that are not triggered lexically but are more context-dependent (cf. generalized vs. particularized implicatures [4]). In this study, we investigated the neurophysiological correlates of scalar and relevance implicature processing, seeking to understand the processing of different implicature types. In short dialogues (N=92), while keeping the answer constant across conditions, we manipulated the type of implicature via the preceding question, testing both scalar and relevance implicatures in a single design (Table 1). In two more conditions, the answer meaning was either literal or incongruent to the question. After each trial, participants had to assess how well the answer replied to the question.

The EEG of right-handed, neurotypical native speakers of German (N=40) was recorded from 32 Ag/AgCl active electrodes. Data was processed in MNE Python. After offline filtering (0.1-30 Hz), and artifact correction, the data was re-referenced to the average of the mastoids. Epochs of 1400 ms were extracted around the critical word (e.g., “warm”), and were baseline-corrected (-200 to 0 ms). After artifact rejection, data from 8 participants was removed.

To explore spatiotemporal effects across channels and time-points, cluster-based permutations [5] (FDR-corrected) were performed on the comparisons between the Literal and each of the other three conditions. Significant clusters (p<.05) were identified for the Incongruent vs. Literal comparison on anterior, central and central-parietal channels at 250-1200 ms, and for the Scalar vs. Literal comparison on posterior and occipital channels at 350-850 ms. There were no significant clusters (p>.05) for the Relevance vs. Literal comparison. To quantify the effects, we conducted confirmatory repeated-measures ANOVAs on pre-defined ROIs. Results (Table 2) showed that the effect for the Incongruent condition had a more frontal topography (Fig.1), while that for the Scalar condition was larger over posterior and occipital channels.

The frontal negativity for the Incongruent condition may reflect an Nref effect [6], indexing listeners’ difficulty in establishing meaning based on incoherent answers. Furthermore, we found evidence that scalar and relevance implicatures are not processed uniformly, with the former eliciting a posterior positivity on the scalar adjective (contrary to findings on quantifiers [7]) and the latter showing no difference from the literal condition. Overall, our findings suggest that listeners rapidly generate meaning from under-informative answers in dialogue settings.

References

[1] Hagoort & Levinson (2014) Neuropragmatics. [2] Bischetti, Frau, & Bambini (2022) Neuropragmatics. [3] Politzer-Ahles (2020) *LL Comp*. [4] Grice (1975) Logic and conversation. [5] Maris & Oostenveld (2007) *J. Neurosi. Methods.* [6] Nieuwland & Van Berkum (2008) *LL Comp.* [7] Politzer-Ahles, Fiorentino, Jiang & Zhou (2013) *Brain Research*.

Table 1: Example experimental item

Question (written)	**Answer** (auditory)
Scalar: Ist das Wetter bei dir heiß? (*Is the weather hot there?)*	Es ist **warm** heute. *(It is warm today.)*
Relevance: Gehst du heute ins Freibad? (*Are you going to the pool?)*	
Literal: Wie ist das Wetter bei dir? *(What is the weather like there?)*	
Incongruent: Was ist deine Lieblingseissorte? (*What is your favorite ice-cream?)*	

Table 2: Results - ANOVAs with ROIs (top tier: Midline, bottom tier: Laterality and Longitude)

	Violation vs. Literal (300-1200 ms)			**Scalar vs. Literal (400-800 ms)**		
	F(df)	p	η^2	F(df)	p	η^2
Condition	**F(1,31) = 14.08**	**<.001**	**.312**	F(1,31) =.02	.879	.001
Midline	F(3,93) = 1.64	.186	.050	F(3,93) = 1.57	.202	.048
Condition:Midline	**F(3,93) = 16.31**	**<.001**	.345	**F(3,93) = 6,96**	**<.001**	**.183**
Condition	**F(1,31) = 20.74**	**<.001**	**.401**	**F(1,31) = .60**	**.447**	**.019**
Laterality	F(1,31) = 65.93	<.001	.680	F(1,31) = 57.02	<.001	.648
Longitude	F(2,62) = 22.89	<.001	.425	F(2,62) = 6.81	.002	.180
Condition:Laterality	**F(1,31) = 13.58**	**<.001**	**.305**	F(1,31) = .40	.532	.013
Condition:Longitude	**F(2,62) = 29.72**	**<.001**	**.489**	**F(2,62) = 10.88**	**<.001**	**.260**
Laterality:Longitude	F(2,62) = 2.71	.074	.080	F(2,62) = 6.59	.002	.175
Cond:Lateral:Long	**F(2,62) = 7.09**	**.002**	**.186**	F(2,62) = .30	.742	.010

Note. Cond:Lateral:Long = Condition x Laterality x Longitude

Figure 1: Topographic maps of the comparisons across conditions