Surprise as a Measure for the Interaction of Pragmatics with the Lexicon in Sentence Meaning Composition

It has been widely acknowledged that a preceding discourse can influence the way sentence meaning is composed from lexical meaning. A prominent view is that the contextual influence is mainly due to the semantic similarity between parts of the discourse context and the words in the target sentence. It is however highly controversial whether also pragmatic aspects of the discourse context other than the mere resolution of indexicals and anaphors can immediately affect sentence meaning composition.

To investigate the contrast between a Semantic Similarity and a Free Pragmatic account we will look into the way subjects make probabilistic predictions on the completion of a sentence given a preceding discourse. Quantitatively, the semantic similarity can be determined by Latent Semantic Analysis (Landauer & Dumais, 1997), whereas we will use the framework of Bayesian Pragmatics (Frank & Goodman, 2012) to calculate the pragmatic influence – in particular, concerning the rationality of the speaker's intentions in a narrative. As a model of lexical structure we apply the Generative Lexicon approach (Pustejovsky, 1995).

The general idea of Bayesian Pragmatics, also known as Rational Speech Act Theory, is to account for the rational cooperation between speaker and hearer in an act of communication by modelling the hearer's probabilistic expectations about the speaker's communicative intentions by Bayes's Theorem. The speaker's choice of words is assumed to pursue the aim of optimzing informativity and relevance. Bayesian pragmatics has been successfully used to explain results in a number of behavioral experiments (e.g., Frank & Goodman, 2012). It offers itself as a model also in what we call the Predictive Completion Task (PCT) of communication. Here, the hearer at every moment in a communicative situation has to generate a probabilistic prediction about how a discourse being uttered by the speaker will be continued. The hearer's expectation is modelled by a predictive probability function, whose negative logarithm serves as a measure of surprise.

The Semantic Similarity and the Free Pragmatic views provide competing theories of how the hearer accomplishes the Predictive Completion Task. According to the first view, the predictive probability function should depend solely the semantic similarities between the lexical meaning of the continuing word and the semantic properties of the preceding context. The Free Pragmatic View in contrast maintains that pragmatic aspects of the discourse directly interact with meaning components retrieved from the lexicon as well as with any further node in the sentence meaning composition tree (Recanati, 2012). It thus challenges a rigorous notion of compositionality, according to which the meaning of a complex expression is determined by the meanings of its syntactic parts and the way the parts are combined (▮▮▮▮▮, 2004, 2012). In the PCT, Bayesian Pragmatics can be used to quantitatively model the Free Pragmatic account.

The contrasting quantitative predictions of the Semantic Similarity and the Free Pragmatic views can be applied to a previous EEG experiment of ours (▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮ 2017; ▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮ 2017). Here we combined a particular idea of Pustejovsky's (1995) Generative Lexicon approach with Gibson's (1979) notion of affordances. According to the Generative Lexicon approach, the lexical entry of concrete nouns (e.g. *banana*) specifies a so-called Telic component (e.g. *eat*) that is retrieved in sentence meaning composition. This retrieval is typically triggered by verbs like *use* and *enjoy* that take the respective noun as argument. This explains why sentences such as (a) are typically understood as having the meaning of (b):

(a) *The child enjoyed the banana.*

(b)The child enjoyed <u>eating</u> the banana.

Gibson proposed that many objects come with subject- and situation-dependent affordances. We distinguish between *ad-hoc affordances* and *generic affordances*. Generic affordances are affordances of a class of objects that are represented as part of the mental concept of the class (e.g., *chair – sit*). Ad-hoc affordances are affordances that a particular object has for a particular agent in a particular situation (e.g., *this chair – hide under*, for a child in a peekaboo game). Generic affordances are stored as *telic components* in the lexicon of nouns.

	+TLex	−TLex
TStd-Ctx	Claire got herself a funnel to perform a little chemistry experiment at home and to this end she put some dye in water. Once she has done so, she uses the **funnel** to **<u>pour</u>** water into a container.	Claire got herself a funnel to perform a little chemistry experiment at home and to this end she put some dye in water. Being an unconventional person, she uses the **funnel** to **<u>hang</u>** her coat.
TNew-Ctx	Claire has an extra funnel and, after having decided what to do with it, she glues it to the wall leaving the narrow end facing outward. Once she has done so, she uses the **funnel** to **<u>pour</u>** water into a container.	Claire has an extra funnel and, after having decided what to do with it, she glues it to the wall leaving the narrow end facing outward. Being an unconventional person, she uses the **funnel** to **<u>hang</u>** her coat.

Table 1. Sample stimuli for EEG experiment on context effects on Telic lexical component.

In our 2x2 experimental design (see Tab. 1) the first variable varied the two conditions, +TLex vs. −Tlex, i.e., whether the cue verb (e.g., *pour* or, respectively, *hang*) expresses the telic component in the lexical entry of a given noun n (e.g., *funnel*) and thus has a high or low semantic similarity to the noun. With regard to the second variable, we varied the discourse context such that, in the first condition, TStdCtx, a standard context preceded the target sentence, whereas in the second condition TNewCtx the preceding discourse context introduced a new telic role as an ad-hoc affordance for the object denoted by the noun, facilitating an action expressible by the −TLex verb (*hang*). The semantic similarities between the verbs and the contexts (excluding the noun) were held constant

The reported differences in the EEG signal (the N400 component) are best explained by the assumption that the hearer accomplishes the Predictive Completion Task as envisaged by the Free Pragmatic rather than the Semantic Similarity View. Similar results were obtained in analogous study concerning the agentive component in the lexicon of concrete nouns.

References

████████████████████████████ (2017). The time-course of sentence meaning composition. N400 effects of the interaction between context-induced and lexically stored affordances. *Frontiers in Psychology*, *8*. doi:10.3389/fpsyg.2017.00813

Frank, M. C., & Goodman, N. D. (2012). Predicting Pragmatic Reasoning in Language Games. *Science*, *336*, 998–998.

Gibson, J. J. (1979). *The Ecological Approach to Visual Perception.* Boston, MA: Houghton Mifflin.

Landauer, T. K., & Dumais, S. T. (1997). A solution to Plato's problem: The latent semantic analysis theory of acquisition, induction, and representation of knowledge. *Psychological Review*, *104*, 211–

240.

Pustejovsky, J. (1995). *The Generative Lexicon*. Cambridge, MA: MIT Press.

Recanati, F. (2012). Compositionality, Semantic Flexibility, and Context-Dependence. In ████████ ███████████████████ (Eds.), *Oxford Handbook of Compositionality* (pp. 175–191). Oxford: Oxford University Press.

████████ (2004). Compositionaltity, Context, Categories and the Indeterminacy of Translation. *Erkenntnis*, *60*, 145–178.

████████ (2012). Non-symbolic compositional representation and its neuronal foundation: Towards an emulative semantics. In ████████████████████████████ (Eds.), *The Oxford handbook of compositionality* (pp. 633–654). Oxford University Press.

████████████████████ (2017). The interaction of Bayesian pragmatics and lexical semantics in linguistic interpretation: Using event-related potentials to investigate hearers' probabilistic predictions. In G. Gunzelmann, A. Howes, T. Tenbrink, & E. Davelaar (Eds.), *Proceedings of the 39th Annual Conference of the Cognitive Science Society* (pp. 3504–3509). Austin, TX: Cognitive Science Society.