

Reference resolution: both given and new can be expected  
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This talk presents the Expectancy Hypothesis as a framework for understanding why certain entities are more accessible than others for the purpose of reference resolution (Arnold, 1998, 2001; Arnold & Tanenhaus, in press; Arnold, Brown-Schmidt & Trueswell, 2006). The Expectancy Hypothesis suggests that entities in the listener's discourse model become more accessible when the listener perceives that there is a higher likelihood of that referent being mentioned. This "expectancy" is calculated probabilistically and dynamically, based on multiple sources of information.

The Expectancy Hypothesis builds on prior work, which has shown that the comprehension of referential expressions is facilitated when they refer to entities that are accessible in the discourse. This is particularly true for attenuated expressions like pronouns or deaccented noun phrases, which also tend to be produced in contexts where the referent is cognitively accessible in the minds of the discourse participants (e.g., Ariel, 1990; Grosz, Joshi & Weinstein, 1995; Gundel et al., 1993). Entities that have already been mentioned (i.e., those that are **given** in the discourse) are generally more accessible than new (unmentioned) entities (e.g., Chafe, 1976, 1994), particularly those that have appeared in prominent positions, like the grammatical subject (Brennan, Friedman, & Pollard, 1987), focus constructions (Almor, 1999; Arnold, 1998) or in positions that are syntactically parallel to that of the referring expression (Chambers & Smyth, 1998). This accessibility facilitates comprehension of both pronouns (Arnold, Eisenband, Brown-Schmidt, & Trueswell, 2000; Gordon et al., 1993) and deaccented noun phrases (Arnold, 2006; Dahan et al., 2001; Terken & Nootboom, 1987). It has also argued that some semantic roles are more accessible than others, based on evidence that pronoun comprehension is faster for referents in certain thematic roles (Garnham et al., 1996; McDonald & MacWhinney, 1995). The conditions where comprehension is facilitated also tend to reveal a higher likelihood of speakers producing pronouns (Arnold, 1998; Arnold & Griffin, 2006) or acoustically attenuated noun phrases (Watson, Arnold, & Tanenhaus, 2006).

While it is clear that a set of textual characteristics correlate with reference production and comprehension, the particular set of characteristics comprising this category is heterogeneous. Why is it that they all have similar effects on the comprehenders' perception accessibility? Data from corpus analyses provide an explanation: reference comprehension facilitation occurs for entities in categories that have a higher likelihood of being mentioned (Arnold, 1998, 1999, 2001). Results showed that reference to an entity was statistically more likely if the entity was recently mentioned, if it occurred in subject position, with the thematic role of goal, in the focus of a cleft, or in the syntactically parallel position to the current referring expression. That is, those entities that tend to be preferred as referents of pronouns and definite NPs are also those that are most "expected" at that particular point in the discourse. These patterns provide the basis for people to make probabilistic predictions of the most likely references to occur, which are indeed those that are easiest to interpret (Arnold, 1998; Arnold & Tanenhaus, in press).

The Expectancy hypothesis thus explains why the textual history of the discourse is so powerful in constraining perceptions of accessibility. In addition, it makes predictions about a) the development of reference processing mechanisms, and b) the conditions under which listeners will be biased toward previously referents that do not enjoy any of the textual indicators of accessibility mentioned above.

Part of the Expectancy proposal is that language users acquire an ability to coordinate discourse accessibility with their interlocutors by paying attention to probabilistic referential patterns in discourse. That is, learning how to compute accessibility is data-driven. Children need to learn that accessibility is not egocentrically defined, and then learn how different discourse cues, like order-of-mention, provide partial information about accessibility in the mind of their interlocutor. This contrasts with the idea that order-of-mention is a natural (perhaps innate) primacy effect (see, e.g., Song & Fisher, 2005). If learning how to compute accessibility depends on experience with discourse patterns, then children should initially demonstrate competence with stronger, more statistically reliable indicators of accessibility, and less reliance on weaker sources of information, like order-of-mention (Arnold et al., 2006).

Data from an eye-tracking experiment examined 4- and 5-year-old's ability to use the grammatical-subject-bias and the pronoun's gender during on-line pronoun comprehension (Arnold, et al, 2006). They viewed a picture of two familiar cartoon characters that either had the same or different gender, and heard a story like "Donald is bringing some mail to {Mickey / Minnie}, while a big rain storm is beginning. {He's / She's} carrying an umbrella, and it looks like they're both going to need it." When children heard the pronoun at the beginning of the second sentence, they rapidly looked at the target when the pronoun matched the gender of only one character -- just as rapidly as adults in a similar task (Arnold et al., 2000). However, in the same-gender condition, they did not show the adult-like tendency to rapidly look at the subject (first-mentioned) character.

Fortunately for the young language learner, the subject bias is typically not the only indication of accessibility, but rather it co-occurs with other cues like recency of mention, repeated mention, and the likelihood of physically manipulating the referent. Evidence from these other sources of information can bolster the child's ability to understand the pronoun. In support of this, there is evidence that children successfully understand pronouns when a single referent is made accessible both through the subject-bias and other sources of information (Arnold, 2006; Song & Fisher, 2005).

The second prediction of the Expectancy Hypothesis is that listeners should be able to use multiple sources of information to calculate the accessibility of potential referents, and that in some cases unmentioned ("new") referents can be more accessible than ones that are already given in the discourse. Support for this comes from eyetracking studies that show how listeners are sensitive to disfluency, e.g. if the speaker says "uh" or pronounces "the" as "thee" (/thi/) instead of "thuh", e.g. "Click on [pause] thee uh..." Disfluency occurs when the speaker is having some kind of production difficulty, which is more likely to occur during reference to something that has not been previously mentioned, or to a complex object. If listeners are sensitive to these patterns, they should be able to use speaker disfluency to predict that the referent is more likely to be something "difficult to describe", like something new to the discourse, or something complicated and hard to describe. Arnold et al. (2004) report an eyetracking experiment where disfluent instructions resulted in a bias toward a "new" (previously unmentioned) entity, whereas fluent instructions lead to the traditional bias towards given entities. Arnold et al. (2006) demonstrated that disfluent instructions also produce a bias toward complex, unfamiliar shapes (e.g., a funny squiggle), compared with familiar ones (e.g., a house). Fluent instructions did not induce any bias in this situation. In both cases, the disfluency affected listeners' biases extremely early, beginning about 200 ms after the onset of the critical word. These experiments show that disfluency affects the expectancy of potential referents, and this information is rapidly integrated during on-line reference resolution. The results challenge

the implicit conclusion from the literature that listeners always focus on given information more than new. The Expectancy Hypothesis is consistent with both lines of evidence, suggesting that both given and new information, when expected, can be perceived as accessible during reference comprehension.

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