






Syntactic structure supports the acquisition of emotion and mental state adjectives

Introduction: Learning the meaning of adjectives presents a challenge to young children, even for adjectives that label salient perceptible properties (Booth & Waxman, 2003; Mintz & Gleitman, 2002; Waxman & Markow, 1998, a.o.). How, then, can children acquire adjective meaning for abstract states, like ‘happy’ or ‘confident’? A well-established finding is that syntactic bootstrapping supports the acquisition of abstract verb meaning (Landau & Gleitman, 1985; Gleitman, 1990), because a verb’s argument structure (i.e., the number and position of NPs and the complements it takes) correlates with its meaning. As a result, learners use the presence and type of a sentential complement to deduce that some (but not all) verbs like *think*, *know*, *want*, or *believe* denote mental states (Gleitman et al., 2005; Hacquard & Lidz, 2019). To date, little work has systematically extended this hypothesis to adjectives. Doing so is promising for understanding more about the word learning process and the range and power of syntactic bootstrapping, since some (but not all) adjectives also take complements, even sentential complements. Here, we investigate how syntactic cues from adjectival syntactic complements support the acquisition of one particular type of abstract adjective meaning: adjectives denoting *emotions and mental states*. We demonstrate that while such adjectives may be infrequent in the input, a significant percentage of the time they appear with syntactic complements. We then show across three word learning experiments that both young children and adults actively recruit these syntactic cues to narrow the hypothesis space to an emotion/mental state adjective meaning.

Corpus Search: We analyzed speech of caregivers to English-learning children ages 2-5 years in 44 corpora (CHILDES; MacWhinney, 2000). Here we focus on one aspect of speech: presence and type of syntactic complements within utterances containing an adjective. Out of over 36,000 adjectives, nearly 12,000 denoted size, color, or physical sensation/perception, while only 1,800 labeled emotions or mental states. However, while only 4.2% of *all* adjectives, and 1.5% of color/size adjectives took a syntactic complement, approximately 27% of emotion and mental state adjectives did. Moreover, emotion/mental state adjectives were significantly more likely to appear in predicative (v. prenominal) position, and with animate subjects. Complements were comprised of five main types: ADJ+PP (*about NP*, *at NP*, *of NP*) and ADJ+ finite/non-finite sentential clause. We leverage these complements across our word learning studies.

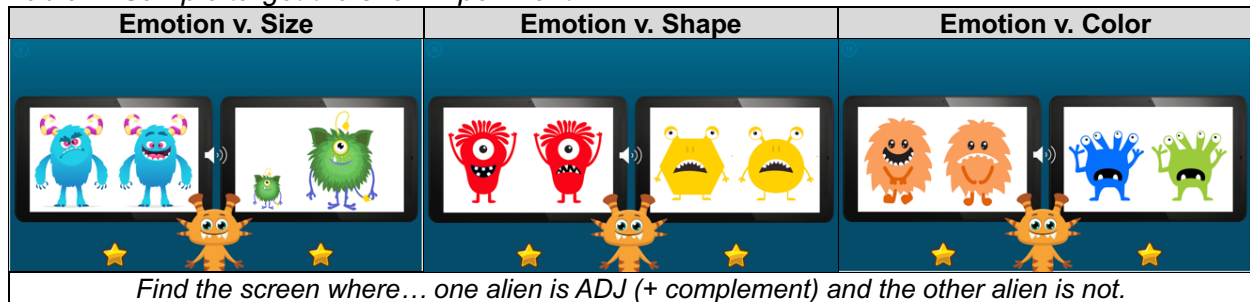
Experiment 1: 51 children (3;0-6;6) and 75 adults participated in a binary forced-choice task manipulating presence/absence of adjectival complement as our between-subject factor. See Figure 1 for sample trial structure. There were five target adjective(+complement) trials. Our dependent measure was choice of emotion match at test. Both children and adults were significantly more likely to choose the emotion match in the Complement condition than in the Baseline condition ($p < .0001$), the latter of which was no different from chance ($p = .51$) (Baseline: children: 45.8%, adults: 40.0%; Complement: children: 75.6%, adults: 93.2%).

Table 1: Sample trial structure for Experiment 1

Familiarization Phase	Contrast	Re-Exposure	Test Phase	
				
Color(yellow)+Emotion (happy)	*Color+*Emotion	✓Color +✓Emotion	✓Emotion *Color	*Emotion ✓Color
These aliens are both... Baseline condition ...daxy.	Uh oh! This alien is NOT daxy...	Yay! This alien IS daxy.	Here are some new aliens!	
Complement condition ...daxy about something.			Which one is daxy?	


Experiment 2: 54 children (3;8-6;6) and 45 adults participated in a binary forced-choice task again manipulating presence/absence of adjectival complement as our between-subject factor. There were 9 target emotion+other property trials (counterbalancing side, and property of shape, size, and color) and four non-target trials. See Figure 2 for sample target trials. Our dependent measure was the assignment of a star to the emotion contrast. While both children and adults were above chance in the Baseline condition ($p < .0001$), perhaps because emotion was always an available contrast choice, they were significantly more likely to choose the emotion contrast in the Complement condition than in the Baseline condition (Baseline: children: 73.5%, adults: 71.0%; Complement: children: 88.3%, adults: 97.6%) ($p < .05$).

Table 2: Sample target trials for Experiment 2



Experiment 3: 58 children (17: 4;11-5;10; 20: 6;1-6;11; 21: 7;0-8;4) and 38 adults participated in an asynchronous word learning study administered on Qualtrics in which participants watched animated Powtoon videos of two characters engaged in dialogue using a novel noun and adjective, then provided their best guess as to the novel adj's meaning. See Table 3 for a sample trial. There were 9 trials: 5 targets (ADJ+target complement), 2 baseline (no complement; see Table 1), 2 controls (ADJ+complement and an expletive or gerundive subject, consistent with subjective adjectives, e.g. *It is troby to do something*). No animacy cues were provided for the novel nouns. Both children and adults were likely to guess adjectives for the novel word, *and* were most likely to guess an emotion/mental state adjective for the target trials. Moreover, all conditions differed significantly from each other (Baseline: children: 20.7%, adults: 8.1%; Control: children: 9.9%, adults: 5.4%; Complement: children: 38.6%, adults: 75.0%). Children were increasingly more adultlike with age. Thus, given the presence of *syntactic* cues with no *visual* cues, participants were able to converge upon an abstract emotion/mental state adjective meaning.

Table 3: Sample dialogue for one target trial of Experiment 3

<p>A: Hey, look, there's a derkum! Do you see the derkum?</p> <p>A: You know, that derkum is troby.</p> <p>A: Mm hmm, the derkum is troby about doing something.</p>		<p>B: Oh yes, I see the derkum.</p> <p>B: You're right. That derkum is troby.</p> <p>B: I agree. The derkum is troby about doing something.</p>
<p>What do you think the word "troby" means? 🖊️ Type your guess in the space below. 🖊️</p>		

Conclusions: Acquiring abstract meaning presents an inherent challenge in word learning. Syntactic complements are a reliable distributional cue in child-directed speech known to support the acquisition of mental state verbs. We show that both children and adults are able to recruit these cues to deduce abstract adjective meaning, arriving at an emotion/mental state interpretation. This research thus extends the syntactic bootstrapping mechanism beyond verbs to adjectives, highlighting the potency of syntax for supporting the acquisition of word meaning.