Article

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The role of explicit contrast in adjective acquisition: A cross-linguistic longitudinal study of adjective production in spontaneous child speech and parental input

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Abstract
Experimental studies demonstrate that contrast helps toddlers to extend the meanings of novel adjectives. This study explores whether antonym co-occurrence in spontaneous speech also has an effect on adjective use by the child. The authors studied adjective production in longitudinal speech samples from 16 children (16–36 months) acquiring eight different languages. Adjectives in child speech and child-directed speech were coded as either unrelated or related to a contrastive term in the preceding context. Results show large differences between children in the growth of adjective production. These differences are strongly related to contrast use. High contrast users not only increase adjective use earlier, but also reach a stable level of adjective production in the investigated period. Average or low contrast users increase their adjective production more slowly and do not reach a plateau in the period covered by this study. Initially there is a strong relation between contrast use in child speech and child-directed speech, but this relation diminishes with age.

Keywords
Adjective production, antonymy, contrast, cross-linguistic, growth curve analysis

Introduction

Adjectives emerge in child speech later than nouns and verbs (Barrett, 1995; Berman, 1988; Caselli, Bates, Casadio, & Fenson, 1995; Ninio, 1988; Stolt, Haataja, Lapinleimu, & Lehtonen, 2008). Also the ability to associate adjectival forms with properties develops much later than the ability to extend noun meanings to novel objects (Booth & Waxman, 2003, 2009; Waxman & Booth, 2001). Late acquisition of adjectives can be partly explained by their relatively low frequencies in the parental input (Salerni, Assanelli, D'Odorico, & Rossi, 2007; Sandhofer, Smith, & Luo, 2000; Tribushinina & Gillis, 2012). Another reason for a late acquisition of adjectives compared to other content-word classes is their conceptual complexity. It is well documented in the literature that toddlers have difficulty attending selectively to one dimension, such as colour or texture (see Smith, 1989 for review). Research on the acquisition of colour adjectives shows, for example, that the ability to conceptually represent colour independently of objects is a prerequisite for learning colour terms (Kowalski & Zimiles, 2006). A child should come to understand that very diverse objects, like apples and fire-trucks, may share the same colour (red) and can, therefore, be described by the same word, *red.*

Another problem with adjective acquisition is that on hearing a novel adjective a child has to determine which of a whole range of attributes displayed by the object is meant (Pitchford & Mullen, 2001). For example, even if the child knows that an adjectival form such as *greyish* denotes a property of a rabbit and even if s/he is able to selectively attend to properties, how can s/he decide which of the many properties (colour, size, manner of motion, etc.) is meant? In the case of nouns, children were shown to be guided by a number of word-learning constraints, such as a whole-object bias, i.e. an assumption that a novel noun refers to the entire object rather than its parts (Markman, 1992). The acquisition of adjectives is in this sense more complex than the acquisition of nouns because

adjectives say something about an object (colour, shape, etc.) but do not refer to the object itself.

One factor that may facilitate the process of adjective acquisition is contrast. In natural communication, adjectives are often used for referent identification because they can help speakers to distinguish between same-class objects (e.g. *Give me the blue cup, not the red one*). Therefore, it is plausible that language learners may benefit from contrastive information for understanding what a novel adjective means and/or even use contrast as a strategy in learning the meanings of novel adjectives. Contrast is understood here as semantic oppositeness rather than a general assumption that two distinct forms should have different meanings (Clark, 1987). For example, if a toddler sees two same-class entities (e.g. rabbits) of different colours (white and grey) and hears one of them being described as *grey* and the other one as *white*, s/he is more likely to get access to the denotation of the words than when they are presented in isolation, without a contrastive background (Carey & Bartlett, 1978). Likewise, presumably the best way to explain to a child what *small* means is to contrast a small object with a big counterpart.

Indeed, several experimental studies demonstrate that children are sensitive to the contrastive function of adjectives (Gelman & Markman, 1985) and that comparison helps toddlers to learn the meanings of novel adjectives (Au & Laframboise, 1990; Au & Markman, 1987; Carey & Bartlett, 1978; Klibanoff & Waxman, 2000). In the absence of the initial within-category contrast, children as old as 3 years of age are not able to extend the meaning of a novel adjective across basic-level categories. For instance, if toddlers learn a novel adjective for 'red' in the visual context of a single red car, they are only able to successfully extend the meaning of the adjective to another object from the same basic-level category (another red car), but not across categories (a red balloon) (Klibanoff & Waxman, 2000; Waxman & Markow, 1998). However, when 3-year-olds are presented with a novel adjective in a (perceptually) contrastive context, they are able to extend adjectives to members of different basic-level categories (Klibanoff & Waxman, 2000; Waxman & Klibanoff, 2000). For example, when children first see two same-category objects, one displaying the target property (e.g. transparent bottle) and one having the contrastive property (e.g. opaque bottle), they are able to correctly extend the meaning of the adjective 'transparent' to an object from another basic-level category (e.g. foil). Likewise, if the same property is initially presented in two objects from different basic-level categories (e.g. transparent plate and transparent toothbrush), children are also able to extend adjective meanings to members of a different basic-level category (Waxman & Klibanoff, 2000).

Parents appear to be sensitive to the advantages of contrastive contexts in adjective learning and sometimes present adjectives in antonymous pairs (e.g. *big–small, good–bad*) or contrast sets (e.g. *green–red–blue–yellow*) (Murphy & Jones, 2008; Tare, Shatz, & Gilbertson, 2008; Voeikova, 2003). By way of illustration, consider the following examples from two Russian corpora of spontaneous mother–child interactions:

(1) (from Filipp corpus, 25 months)
Mother: *A kakoj korabl' iz sebja?*
'And what does the ship look like?'

Mother: *Bol'šoj, malen'kij*?
'Big, small?'
Mother: *Belyj, černyj, krasnyj*?
'White, black, red?'
Filipp: *ėf černyj*.
'Hm, black'.

(2) (from Liza corpus, 29 months)
Mother: *Strašnye zveri ili xorošie, Liza*?
'Are the animals scary or good, Liza?'
Liza: *Strašnye*.
'Scary.'
Mother: *Strašnye razve*?
'Are you sure they are scary?'
Mother: *Xorošie*.
'Good.'

Not only parents, but also young children seem to 'play' with contrasts regularly in their spontaneous conversations with caregivers (Tribushinina, 2013); witness examples (3) and (4) from the same corpora as above:

(3) (from Filipp corpus, 27 months)
Mother: *Xorošaja karakatica.*
'The cuttlefish is good.'
Filipp: *A obez'jana ploxaja*.
'But the monkey is bad.'

(4) (from Liza corpus, 24 months)
Liza: *U korovy bol'šoj xvostik*.
'The cow has a big tail.'
Liza: *Est' malen'kij xvostik*.
'There is a small tail.'
Mother: *U korovy malen'kij vse-taki*.
'So the cow still has a small tail.'
Liza: *U Lizočki bol'šoj xvostik*.
'And Liza has a big tail.'

The idea that children favour antonym use from early on is supported by the analyses of longitudinal spontaneous speech samples from several English-speaking children and their caregivers (Jones & Murphy, 2005; Murphy & Jones, 2008). The results of these studies demonstrate that children use co-occurring antonyms (including adjectives) from early on, with the same communicative functions as in the parental input, and sometimes at greater rates than in the child-directed speech. Murphy and Jones (2008) tentatively suggest that contrastive contexts may function as bootstraps in the acquisition of relational words in general and adjectives in particular. Although the idea that explicit contrast use in child speech (CS) may bootstrap the acquisition of adjectives and other relational terms seems plausible, particularly in the light of prior experimental studies

reviewed above, to the best of our knowledge, this idea has never been investigated in the literature.

The corpus study reported in this article aims to fill this gap and examines the relation between the use of adjectives in contrastive contexts in spontaneous CS and changes in adjective production between ages 2 and 3. Children actively 'playing around' with antonyms and members of contrast sets (e.g. *good–bad, big–small, red–green–blue*) are likely to get a faster access to the adjective category, since comparison and contrast appear to be powerful cognitive mechanisms enabling the child to understand the meanings of relational words (Au & Laframboise, 1990; Au & Markman, 1987; Klibanoff & Waxman, 2000). Therefore, we hypothesize that explicit contrast use in CS has a facilitating effect on the pace of adjective acquisition.

Acquisition involves changes on a number of measures, such as token and type frequencies of adjectives in spontaneous CS (Blackwell, 2005; Tribushinina & Gillis, 2012; Tribushinina, Gillis, & De Maeyer, 2013), adjective comprehension (Barner & Snedeker, 2008; Kowalski & Zimiles, 2006; Maratsos, 1973; Smith, Cooney, & McCord, 1986), ability to extend adjectives to novel objects (Booth & Waxman, 2003; Klibanoff & Waxman, 2000; Mintz, 2005; Mintz & Gleitman, 2002; Waxman & Booth, 2001; Waxman & Klibanoff, 2000), productive use in novel adjective–noun combinations (Tribushinina, 2008, 2013), diversification of the morphological paradigm (Kilani-Schoch & Xanthos, 2012) and syntactic functions (Nelson, 1976; Saylor, 2000). In this article, we focus specifically on the development of likelihood of adjective occurrence in spontaneous CS. Prior research on early adjective use reveals that children start using adjectives at high pace around the age of 20 months, and by age 3 adjective frequencies in CS reach plateau (Tribushinina & Gillis, 2012; Voeikova, 2003, 2011). Frequency growth goes hand-in-hand with the acquisition of adjectival morphology and syntax. Tribushinina et al. (2013) report that around age 2 children use adjectives in single-word utterances and telegraphic phrases, whereas 3-year-olds produce adjectives in full syntactic constructions (attributive, predicative, adverbial) and inflect them at adult rates. Hence, important developments in the formation of the adjective category start around the age of 20 months and take about a year. Therefore, in this study we investigate adjective use by children between 16 and 36 months of age.

As children grow older, their adjective use is likely to change as a function of cognitive maturation. Additionally, it is possible that rates of antonym co-occurrence in CS also influence the growth of adjective use. Thus, in this research we attempt to establish whether spontaneous adjective use in contrastive contexts adds something to the effects of age as a predictor of changes in the probability of adjective occurrence in CS.

Another goal of this article is to explore the relationship between contrast use in CS and child-directed speech (CDS). It might be the case that heavy antonym use in CS is associated with a particular cognitive style (cf. Riding, 2010), whereby children extensively rely on comparison and contrast to explore the world around them. In this case, children who frequently use adjectives in contrastive contexts do not necessarily have to receive input containing a lot of co-occurring antonyms. However, it is also possible that contrast use by the child is related to frequencies of contrastively used adjectives in the CDS. In line with this prediction, Murphy and Jones (2008) observed that input to heavy antonym users contains more co-occurring antonyms than input to children who are low

contrast users. Thus, contrast use in CS appears to be related to contrast use in CDS. In the present research we test the generalizability of these findings using a larger corpus of parent–child interactions in various languages.

Finally, relatively little attention has been given to the acquisition of adjectives in languages other than English (Aksu-Koç, 2011; Ravid & Nir, 2000; Tribushinina & Dubinkina, 2012; Tribushinina & Gillis, 2012; Tribushinina et al., 2013; Waxman & Guasti, 2009) and cross-linguistic studies of adjective acquisition are still virtually nonexistent (Tribushinina, 2008; Waxman, Senghas, & Benveniste, 1997). The importance of cross-linguistic research in the field of language acquisition can hardly be overestimated, and it appears to be particularly important in the domain of adjective learning, since adjectives are not a universal category (some languages map properties to nouns and some to verbs) (Bhat, 1994).There is indication in the literature that certain typological features can facilitate adjective learning (Sandhofer & Smith, 2007; Waxman & Guasti, 2009; Waxman et al., 1997; Yoshida & Hanania, 2013). For example, children acquiring Spanish where adjectives are commonly used in nominalized constructions (e.g. *el suave* 'the smooth'), which makes them less distinguishable from nouns, were shown to map adjectives to both properties and taxonomic categories at the age that children acquiring English and French already map adjectives specifically to properties (Waxman et al., 1997, cf. Courtney, 2010). It can be hypothesized that children acquiring languages with rich adjectival morphology which is clearly different from noun (and verb) morphology (e.g. Croatian, German, Lithuanian, Russian, and to a lesser degree French) get a faster access to the adjective category compared to children whose language contains (relatively) scarce adjectival morphology and/or adjectival morphology that is not clearly distinguishable from the noun morphology (e.g. Dutch, Italian, Turkish).

Not only inflectional properties of the target languages, but also word-order characteristics can be relevant for adjective acquisition (Nicoladis & Rhemtulla, 2012). A word-learning study reported in Yoshida and Hanania (2013) shows that (English-speaking) 2-year-olds are better able to map adjectives to correct properties if a novel adjective is preceded by a noun denoting the object category (e.g. *elephant vap*), i.e. in the order that is ungrammatical in English. Based on these findings, it might be expected that children acquiring languages allowing a postnominal position of attributive adjectives (e.g. primarily French, but also Italian, Lithuanian and Russian) learn adjectives faster.

Method

Subjects and data

Longitudinal samples of spontaneous speech from 16 children (two per language) and their caregivers were targeted for analysis (see Table 1). All participants were monolingual speakers of their languages from upper-middle-class families. The corpora used in this study contain audio recordings of spontaneous interactions between children and their caregivers. The recordings were made in unstructured home settings (e.g. eating, washing, book reading, having a bath). Each recording was transcribed using the CHILDES CHAT transcription format (MacWhinney, 2000). The transcriptions were automatically tagged with the CHILDES MOR software tool (adapted for the eight

Table 1. The sample.

Child name	Subject code	Sex	Language	Period studied (months)	Utterances in CS	Adjective tokens in CS	Utterances in CDS	Adjective tokens in CDS	Corpus source
Antonija	A	f	Croatian	19–31	5055	189	7593	604	Kovacevic (2002)
Marina	Ma	f	Croatian	17–29	4433	132	6534	356	Kovacevic (2002)
Peter	P	m	Dutch	20–31	4197	503	12,490	2652	Bol (1995)
Sarah	S	f	Dutch	20–32	4957	312	6972	1186	Van Kampen (1994)
Emma	Em	f	French	16–32	5613	773	6088	840	Kilani-Schoch (2003)
Sophie	So	f	French	18–32	9774	989	13,800	1463	Kilani-Schoch (1997)
Jan	J	m	German	20–32	5805	566	9969	3032	Korecky-Kröll (2011)
Lena	Le	f	German	20–32	4394	187	8039	1273	Lettner (2008)
Camillo	C	m	Italian	24–36	2730	156	1896	283	Noccetti (2002)
Rosa	R	f	Italian	19–32	6686	437	4063	578	Cipriani et al. (1989)
Elvijus	E	m	Lithuanian	17–30	16722	835	14,920	1100	Kamandulyte (2009)
Monika	M	f	Lithuanian	20–32	15438	612	31,615	2194	Kamandulyte (2009)
Filipp	F	m	Russian	17–29	8016	723	11,080	1133	Voeikova (2011)
Liza	L	f	Russian	20–32	3885	344	10,052	943	Gagarina (2008)
Irem	I	f	Turkish	20–32	8184	88	22,290	879	Ural, Yüret, Ketrez, Koçbaş, and Küntay (2009)
Mine	Mi	f	Turkish	20–32	1691	99	2645	180	Aksu-Koç (1998)

languages) producing morphological decomposition and part-of-speech tagging. The resulting tags were manually verified by the authors of this article. The morphological coding allowed an automatic extraction of all utterances containing an adjective.

Even though adjectives can emerge in child speech as early as at 15 months, their frequency remains very low until the age of 20 months (Stolt et al., 2008; Voeikova, 2011). As explained in the Introduction, children start acquiring adjectives at high pace from around 20 months of age. By age 3 adjective frequencies in CS tend to reach the adult level; increase in adjective production is accompanied by morphosyntactic consolidation of the adjective category in CS (Tribushinina & Gillis, 2012; Tribushinina et al., 2013). This means that important developments in the acquisition of adjectives start around the age of 20 months and take about a year. Therefore, the period between the children's second and third birthdays appears to be the most informative about the role of explicit contrast in developing adjective production.

Each child was followed for, at least, a year, starting from the month when s/he produced the first adjective. For example, the first adjective occurrence in the Sarah corpus was at the age of 20 months. Since we were interested in the first year of adjective acquisition, the period between 20 and 32 months was targeted for analysis. As is evident from Table 1, in several corpora the first adjective was attested (much) earlier than around the age of 20 months. For example, the first adjective in the Emma corpus was attested already in the recording made at 16 months. However, adjective use in these early recordings was very infrequent and non-productive. In such cases, the children (Emma, Sophie, Elvijus) were followed for a period longer than 12 months. The Dutch-speaking boy Peter was followed for 11 months, because no recording at 32 months was available.

As shown in Table 1, the corpora used in this study vary in size, which is due to differences in the duration (and density) of recordings and varying talkativeness of the participants. For example, the Lithuanian boy Elvijus was recorded more often than the other children in our sample and is also an early talker producing a lot of speech in conversations with his mother but also alone (Kamandulyte, 2009). In contrast, the Italian-speaking boy Camillo and the Turkish-speaking girl Mine were recorded less frequently and are also less talkative, even though they are both typically developing children (for Camillo see Noccetti, 2002, 2003, 2009; for Mine see Ketrez, 1999; Küntay & Slobin, 2001).

An advantage of the statistical method used in this investigation (growth curve analysis by means of a multilevel logistic regression, see description below) is that it takes every data-point into account and allows for missing values and differences between the corpora in the number and timing of recordings (Quené & Van den Bergh, 2008). Since individual growth curves for each child are estimated, it is not a problem that the corpora vary in size and that some children were followed a bit longer than others (this will result in larger uncertainties of the estimates at time points with fewer observations).

Coding

The coding was performed by the authors of the article, native speakers of the respective languages. Each adjective in CS and CDS was manually coded as either unrelated (containing no contrastive terms in the preceding context) or related (containing a contrastive term in the preceding context) by adding a dependent (semantic) tier to the main tier, i.e. to the utterance containing an adjective.

Previous corpus studies (of written language) show that antonymous adjectives co-occur within sentences more often than would be expected by chance (Jones, 2002; Justeson & Katz, 1991; Lobanova, 2012). However, when dealing with spoken language and especially with early CS (and CDS attuned to young children), a single utterance is often too short to capture the relevant semantic relations in discourse. Contrasts in CS and CDS can be established between several (short) utterances (Tribushinina, 2013). Earlier research shows that, at least, five preceding utterances should be considered in order to capture relevant semantic relations between adjectives in parent–toddler interactions (Voeikova, 2003). Therefore, preceding context was operationalized in this study as either the same utterance or five utterances preceding the target utterance (i.e. the utterance containing an adjective).

Contrastive terms coded in this study included two categories – antonyms and members of contrast sets. Antonyms are pairs of adjectives having an opposite meaning (e.g. *big–small, good–bad, open–closed*), whereas contrast sets involve non-binary incompatible terms, such as colour terms (e.g. *red–green–blue–yellow*) and shape adjectives (e.g. *round–oval–square–rectangular*) (Givón, 1970; Lehrer & Lehrer, 1982; Murphy, 2003).

For each adjective token we searched for a semantically opposite adjective (which we consider to be a trigger of the contrast relation) in the same utterance and in the broader context of five preceding utterances. These five utterances included speech by both the child and the caregivers. If a contrastive trigger was found, the adjective was coded as related to a contrastive term; otherwise it was coded as unrelated. The trigger utterance could have been produced either by the child or by her/his interlocutor. An example coding is provided below:

(5) (from Peter corpus, 27 months, situation: playing with a garage)

Caregiver:	*Nou mag die er door heen.*
	'Now it can drive through.'
Child:	*Die gaat ... die gaat er door heen*.
	'It's going … it's going through.'
Child:	*Hoepla*.
	'Whoops.'
Child:	*Nu gaat ie weer door heen*.
	'Now it's going through again.'
Child:	*Deze mag …*
	'This one may …'
Child:	***Deze deze is vast***.
	'This one this one is fixed.'
	%sm1: UNR|vast
Child:	***Deze is los*.**
	'This one is loose.'
	%sm1: RLC:ANT|los

The first adjective in this fragment, *vast* 'fixed', was coded as unrelated (UNR) because it was not preceded by a contrastive term in the preceding five utterances. The second adjective, *los* 'loose', was coded as related to an antonym in the preceding context (RLC:ANT) because it is preceded by *vast* 'fixed' in the previous utterance. Thus, in this case both the target adjective (*los* 'loose') and its contrastive trigger (*vast* 'fixed')

were produced by the same speaker. If an utterance contained more than one adjective, each adjective was coded on a separate dependent tier (%sm1, %sm2, etc.).

Notice that antonymy is a continuum from canonical antonyms (that co-occur at higher rates and are more entrenched in the mind) to accidental opposites contrasted in a specific context (Paradis, Willners, & Jones, 2009). Prior research on the acquisition of antonymy shows that children and their caregivers use both canonical antonyms as in (5) and non-canonical opposites as in (2); the proportion of non-canonical antonyms appears to decrease as a function of child's age (Murphy, 2004; Tribushinina & Dubinkina, 2012). Therefore, both canonical and non-canonical antonyms were coded as related in this study.

Within contrastively used adjectives, co-occurring antonyms and members of contrast sets were almost equally frequent in CS (49% antonyms) and CDS (56% antonyms). In view of low adjective frequencies (and even lower frequencies of co-occurring contrasts), antonyms and members of contrasts sets will be not analysed separately.

Reliability

We recoded 10% of the data approximately 10 months after the final coding. The intra-coder agreement was 97.8% for Croatian, 99.4% for Dutch, 96.2% for French, 98.3% for German, 100% for Italian, 98% for Lithuanian, 98.2% for Russian and 99.7% for Turkish.

Analysis

Growth curve analyses by means of a multilevel logistic regression were performed (Goldstein, 1979). This method statistically models the development of adjective occurrence over time, at the same time keeping track of individual differences between children. This is important as the language use in successive recordings of the same child is more alike than language use in successive recordings of different children. Hence, we need to estimate the variance within children (between different recordings) as well as the variance between children.

Changes with age, or more in general growth, can be estimated by means of several types of models. One kind of model are so-called polynomials, in which the dependent variable is modelled as a function of powers of age (age^0, age^1, age^2, etc.). Such polynomials are extremely flexible and can take almost any shape depending on the number of parameters and the value of the regression coefficients. In polynomials higher order terms are only taken into account if all lower order terms reach significance. That is, a cubic term is only kept in the model if age^1 and age^2 contribute significantly to the description of the occurrence of adjectives. Differences in growth between individuals can also be modelled by means of polynomials by allowing regression weights (β_0*age^0, β_1*age^1, β_2*age^2, etc.) to vary between individuals. This boils down to the estimation of the mean regression weight and its variance between children. The different variance components between children in adjective use might be explained by some other characteristics of their language use, such as the use of co-occurring contrastive terms.

So, differences in contrast use can 'explain' variance between children in adjective use. Moreover, effects of contrastive contexts need not only to be restricted to so-called

Table 2. Parameter estimates for a third order polynomial for the occurrence of adjectives (age has been centred to (age – 25 months); parameter estimates in logits [$LN(\frac{F}{N-F})$]).

Parameter	Fixed		Parameter	Random	
	Estimate	(SE)		Estimate	(SE)
β_0*age^0	–2.514	(0.157)	Var (β_0)	0.391	(0.140)
β_1*age^1	0.048	(0.023)	Var (β_1)	0.007	(0.003)
β_2*age^2	–0.010	(0.001)	Var (β_2)	0.0001	(0.00006)
β_3*age^3	0.001	(0.0003)			

main effects (children who are, on average, high contrast users are also likely to use adjectives, which is evident) but can pertain to interactions with age as well. That is, the change in adjective use over time depends on antonym co-occurrence as well.

Contrast use in CS might be related to contrastive adjective use in CDS. This relation can be disentangled in two different effects: a main effect and a time-dependent effect. A main effect indicates that there is a constant relation between contrast use in CS and CDS. A time-dependent effect shows that the strength of this relation changes as a function of children's age. Both effects will be targeted in the analysis.

Results

In order to give an adequate description of the occurrence of adjectives a third order polynomial proved necessary. The parameter estimates and their respective standard errors are presented in Table 2.

At the age of 25 months, which due to the centring of age coincides with the intercept, the average use of adjectives (in tokens) equals ($\frac{1}{(1+e^{-(-2.514)})}$ =) 0.07. However, at this age the differences between children are large. An 80% confidence interval at this moment in their development ranges from 0.03 to 0.19. As apparent from Table 2, adjective use changes with age; all fixed coefficients (β_1, β_2 and β_3) prove significant ($\frac{|\text{estimate}|}{\text{standard error}} > 1.95; p < 0.05$). From these estimates the average adjective use at each age can be approximated. For instance, at the age of 20 months the average probability of adjective use equals [$\frac{1}{(1+e^{(-(-2.514+0.048*(20-25)-0.010*(20-25)^2+0.001*(20-25)^3))})}$ =] 0.04, whereas at 30 months the average use of adjectives is estimated as [$\frac{1}{(1+e^{(-(-2.514+0.048*(30-25)-0.010*(30-25)^2+0.001*(30-25)^3))})}$ =] 0.08. Also the variance in the linear and quadratic component proved significant ($\frac{|\text{estimate}|}{\text{standard error}} > 1.65; p < 0.05$). Hence, the development of adjective use varies between children.

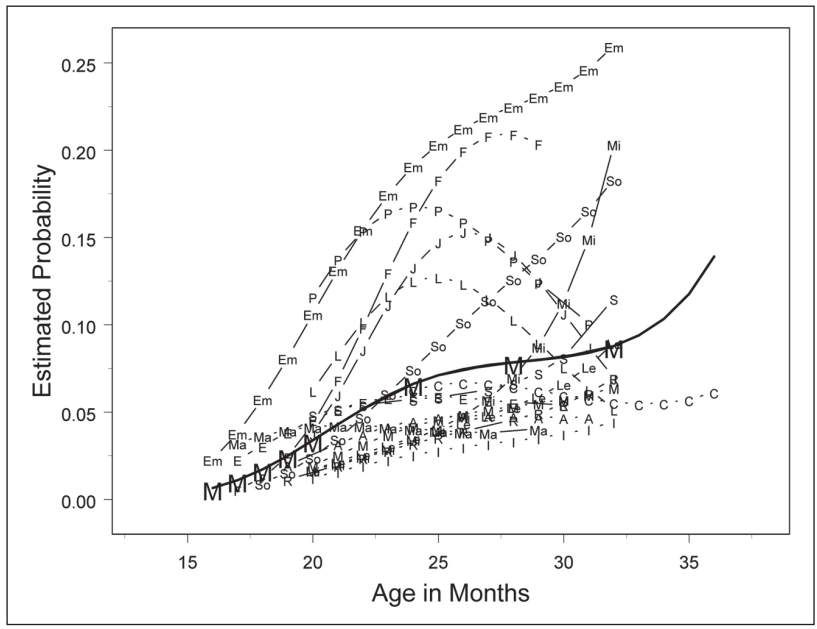

Figure 1. Estimated growth curves of adjective use (tokens) in CS, M: average change over time.

Although in general the larger a logit the larger a probability, we have to bear in mind that a logit transformation is a non-linear transformation. Therefore, in Figure 1 the estimated development is presented in terms of probabilities (for each individual child).

Age significantly affects the probability of adjective occurrence. Since each line in Figure 1 represents an individual child, differences between children can be seen. Some children (e.g. Emma, Filipp, Peter) use adjectives relatively frequently, whereas other children (e.g. Irem, Marina, Antonija) use them quite rarely. For most of the children a steady increase in the probability of adjective use can be observed. This said, some of the children reveal a different pattern. For example, the probability of adjective occurrence in the speech of Peter, Jan, Lena and Elvijus first increases and then starts decreasing around the age of 25 months.

Virtually no differences in adjective use between children acquiring different languages can be shown. Only for the Turkish-speaking children did a marginal significant difference in development appear, i.e. Turkish children seem likely to increase adjective use a bit faster. However, based on a sample of only two learners of Turkish, generalizations are not warranted.

In the second (and last) model the number of contrastively used adjectives is also taken into account, along with the effects of age. Use of contrastive adjectives significantly affects probability of adjective occurrence in CS. When the use of contrastive adjectives is taken into account the differences in adjective production between children have decreased dramatically. The variance of the intercept (variance of β_0) has decreased

Table 3. Parameter estimates for the effect of explicit contrast on adjective use (age centred around 25 months).

Parameter	Fixed		Parameter	Random	
	Estimate	(SE)		Estimate	(SE)
β_0*age^0	–2.613	(0.063)	Var(β_0)	0.243	(0.103)
β_1*age^1	0.061	(0.028)	Var(β_1)	0.001[b]	(0.001)
β_2*age^2	–0.006	(0.002)	Var(β_2)	0.000[b]	(0.003)
β_3*age^3	0.001	(0.001)			
β_4*%contrast[a]	0.239	(0.042)			
β_5*%contrast*age^1	–0.014	(0.007)			

[a]Average contrast use centred around the grand mean (0.56).
[b]Not significant.

($\frac{0.391-0.243}{0.391}*100=$) 38%, and the variance in (linear) growth (variance of β_1) has decreased ($\frac{0.007-0.001}{0.007}*100=$) 86%. As the variance in growth does not reach significance anymore (see Table 3), we cannot show differences in developmental patterns between children in adjective use once contrast use is taken into account.

Table 3 shows that there is an effect of explicit contrast use (β_4), as well as a combined effect of age and explicit contrast use (β_5) on the probability of adjective occurrence in CS. From the parameter estimates it can be inferred that high contrast users (+2SD) are likely to produce more adjectives than low contrast users (–2SD). However, differences depend on the age of the child as well; at the start and at the end of the investigated period differences are smaller than around the age of 25 months (see Figure 2). For high contrast users there is hardly any change in the probability of adjective occurrence after the age of 26 months, while low contrast users keep increasing their adjective use as a function of contrast use and age. So all in all, high contrast users are not only likely to use more adjectives but also seem to increase their adjective use at an earlier age.

Thus, contrast use influences adjective production in CS and this effect of contrasts depends on the age of the child. Children's contrast use, however, is influenced by parental use of adjectives in contrastive contexts. If parents use contrastive adjectives relatively frequently, then their children are also likely to do so. This effect is clearly dependent on the age of the child; the older a child gets, the less strong the effect is. In Table 4 the parameter estimates for the effect of contrast use in CDS on contrast use in CS are presented. Just as in the previous model, age is used as an explanatory variable.

From the parameter estimates it is apparent that we cannot show that contrast use by children changes with age once contrast use by parents is taken into account (β_1*age^1 is not significant). Hence, children's production of adjectives in contrastive contexts depends heavily on parental use of contrastive adjectives (β_2*C_CDS, which is significant), but this influence decreases significantly with a child's age (β_3*C_CDS*age^1).

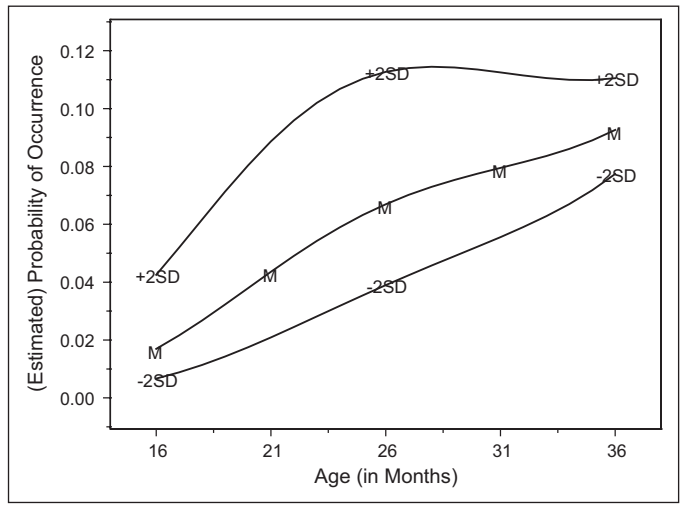

Figure 2. Effect of contrast use on the probability of adjective occurrence.

Table 4. Parameter estimates for the effect of parental contrast use on children's contrast use (age centred around 25 months).

Parameter	Fixed		Parameter	Random	
	Estimate	(SE)		Estimate	(SE)
β_0*age^0	–5.06	(0.26)	Var(β_0)	1.05	(0.39)
β_1*age^1	0.06[a]	(0.05)	Var(β_1)	0.03	(0.01)
β_2*C_CDS	10.88	(5.3)			
β_3*C_CDS*age^1	–2.94	(1.1)			

[a]Not significant.

Discussion and conclusion

The acquisition of adjectives is known to be more demanding for children than the acquisition of other content-word classes, such as nouns and verbs. Prior experimental research has repeatedly shown that children benefit from contrastive information when learning new adjectives (Au & Laframboise, 1990; Au & Markman, 1987; Carey & Bartlett, 1978; Klibanoff & Waxman, 2000; Waxman & Klibanoff, 2000). Extending this research line to adjective use in spontaneous CS, the present study set out to explore whether explicit contrast use (i.e. co-occurring antonyms and members of contrast sets) in child language and parental input has an effect on the probability of adjective occurrence in CS and on the growth of adjective use.

The results of this longitudinal study demonstrate that the development of adjective use (in the investigated period) varies largely between children and even more so with age. Importantly, these differences in acquisition between children are related to the

average use of adjectives in contrastive contexts. When differences in contrast use are accounted for, hardly any differences between toddlers in the growth pace remain.

It is also important to note that the effect of using explicit contrasts depends on age. High contrast users appear to increase adjective use faster than low contrast users, the differences being starkest around the age of 25 months. After 26 months of age the growth in the probability of adjective occurrence by high contrast users diminishes. Low and average contrast users show a slower increase, but this increase continues during the whole investigated period (16–36 months). Thus, high contrast users not only demonstrate a faster growth of adjective occurrence in their spontaneous speech, but also reach a stable level of adjective use in the investigated period.

This study also revealed that the probability of contrast use in CS depends on the use of adjectives in contrastive contexts in CDS. However, this effect decreases with age as children gradually come to use contrastive adjectives more independently (cf. Van Veen, 2011). Hence, there is a causal chain between contrast use by parents and contrast use by children, which in turn influences adjective production in CS. It can be concluded that children benefit from parental input in which adjectives (relatively) often co-occur with their antonyms. More generally, this means that the acquisition of relatively infrequent and conceptually complex word classes (in this case, adjectives) can be facilitated by qualitative aspects of the input children receive (in this case, co-occurring contrasts).

Despite the fact that this study included typologically diverse languages that differ with respect to the richness of adjectival morphology and adjective–noun order, we did not observe any significant cross-linguistic differences in the growth of adjective use. Only the development of adjective production in the language of the Turkish-speaking children was marginally different. It might be the case that development of token frequency is not the correct measure to capture differences in the pace of adjective acquisition across languages. In this case, comprehension experiments or word-learning experiments could reveal differences in the acquisition pace. However, it is also possible that larger and denser samples from children acquiring typologically different languages are needed in order to compare the extent to which various facets of adjective acquisition (e.g. vocabulary vs morphosyntax) are contingent on typological properties of the target language. Unlike language-specific morphosyntactic properties, comparison and contrast are general cognitive strategies (Gentner & Namy, 2004). Therefore, it does not come as a surprise that adjective learning is facilitated by explicit contrast irrespective of the language being acquired.

All in all, the findings suggest that explicit contrast use in parental input and spontaneous CS facilitates the acquisition of adjectives across languages. Hence, the current results obtained from adjective use in naturalistic settings are fully compatible with the findings from the experimental studies indicating that comparison and contrast facilitate the extension of novel adjectives under laboratory conditions (Klibanoff & Waxman, 2000; Waxman & Klibanoff, 2000) and with the idea that contrast may bootstrap the acquisition of relational terms (Murphy & Jones, 2008; Tribushinina, 2013).

Why is contrast so important in the acquisition of adjectives? As explained in the Introduction, young children have difficulty selectively attending to one dimension such as colour or size. Explicitly contrasting two or more (same-kind) objects using adjectival labels (e.g. *Look, this car is big and that one is small*) invites the child to attend to the

dimension(s) where the objects differ; in this way contrast facilitates identification of correct aspects of meaning (Gentner & Namy, 2004). Importantly, the very essence of antonymy is that two incompatible concepts are minimally different, i.e. different on one dimension only (Cruse, 1986; Lyons, 1977). According to Murphy's (2003) definition, a lexical contrast set 'includes only word-concepts that have all the same contextually relevant properties but one' (p. 170). So *short* and *long* are perceived as antonyms (a thing cannot be short and long with respect to the same standard; and these terms contrast only on the scale of length), whereas *cat* and *ant* are not, even though a thing cannot be a cat and an ant at the same time. The principle of minimal difference also explains why antonymy is more central to the adjective class than to any other word class: most adjectives, unlike words from other lexical classes, refer to single properties and therefore easily lend themselves to antonymous relations (Jones, Murphy, Paradis, & Willners, 2012). Thus, understanding contrastive relations between adjectives facilitates selective attention to specific dimensions through comparison and dimensional alignment. Ability to attend to single dimensions in turn creates the need to talk about properties and in that way boosts adjective production in spontaneous CS (Smith, 1989).

There is evidence in the literature that even children much older than age 2 need explicit contrasts to process adjectives. An eye-tracking experiment reported in Sekerina and Trueswell (2012) demonstrated that children as old as 6 years of age need explicit mention of both contrastive terms in discourse in order to be able to use contrastive information for referent identification prior to the onset of the noun. Adults hearing a sentence such as *Give me a RED butterfly* in the visual setting with two butterflies (a red one and a purple one) and a distractor from another basic-level category (e.g. a red fox) are able to predict the target referent before the noun *butterfly* is mentioned. As against this, 6-year-olds are only able to anticipate the reference when the other member of the contrast pair is made salient in the preceding discourse (e.g. *Give me the purple butterfly. And now give the RED butterfly*). Thus, there appears to be a long-lasting effect of co-occurring antonyms and members of contrast sets, not only on production, but also on the processing of adjectives.

Co-occurring antonyms and members of contrast sets also appear to be helpful in establishing word-to-word mappings that play a major role in the acquisition of words with less tangible denotations. A study of colour, number and time terms in CDS (Tare et al., 2008) demonstrated that parents are sensitive to the complexity of such words and regularly provide evidence of what terms belong to the same semantic domain. They do so by asking questions (e.g. *What colour is it?*) and by providing contrasting adjectives in the same utterance, as in example (6) analysed in Tare et al. (2008), which is similar to example (1) above. Hence, it is not surprising that toddlers often answer parental questions about these concepts incorrectly, but in a communicatively adequate way. For example, they may answer using the wrong colour term in response to *What colour is it?* but would rarely answer using an adjective from another semantic domain such as shape or size (Voeikova, 2003, 2011).

(6) (Nina, 26 months)
Mother: *What colour is it?*
Nina: *It's green.*
Mother: *It's green.*
Mother: *You have a green sweater on but you have a white turtleneck on.*

Notice that in (6) Nina's mother explicitly contrasts the two colour terms (*green* and *white*) by means of the adversative conjunction *but*. In future studies, it might be rewarding to investigate the effect of contrastive syntax in CDS on the acquisition of relational terms. The present study has shown that antonym co-occurrence in the input bolsters growth of adjective production by children. It is reasonable to assume that children whose parents relatively often use antonyms in adversative constructions learn adjectives faster. In line with this prediction, Murphy and Jones (2008) found that co-occurring antonyms in the input to heavy contrast users were in 80% of cases used in contrast-emphasizing sentence frames, whereas light contrast users also heard a lot of co-occurring antonyms in contrast-minimizing frames. This difference was starkest at age 2. It is up to future research to test the generalizability of these findings using larger corpora in different languages.

Future investigations should also study the relation between antonym co-occurrence at age *t-1* and adjective use at age *t* on a much denser corpus of spontaneous CS than the ones available to date, in order to firmly establish the causal role of contrast in adjective acquisition. Also more aspects of adjective acquisition should be subjected to scrutiny. This article focused on adjective use operationalized as the probability of (token) occurrence in spontaneous CS. This is an important, but not the only facet in the development of the adjective category; the acquisition process also involves developing productive use in novel adjective–noun combinations, diversification of the adjective vocabulary (type frequency) and increasing comprehension of adjectives. In view of the present results, it is plausible to assume that explicit contrast relations may also have a positive effect on these (and other) aspects of adjective acquisition (cf. Sekerina & Trueswell, 2012). Future work in this area will be crucial to resolving these issues.

It might also be rewarding to study the role of antonym canonicity in more detail. There is evidence that both children and their caregivers use canonical and non-canonical antonyms and that children come to use canonical opposites at higher rates as they grow older (Murphy, 2004; Tribushinina & Dubinkina, 2012). However, it is not known whether co-occurrence of canonical antonyms in CDS has a larger influence on the rate of adjective acquisition than co-occurrence of accidental (contextually relevant) opposites.

This study has revealed that antonym co-occurrence in the speech of children and their caregivers is related to the growth of adjective production in spontaneous CS. It is likely that the same effect can be found for other relational word classes, such as kinship terms, spatial prepositions and verbs (Berman & Clark, 1989; Gentner & Christie, 2010; Gentner, Klibanoff, & Anggoro, 2011; Gentner & Kurtz, 2005; Gentner & Namy, 2004; Murphy & Jones, 2008). However, it is also possible that adjectives are different from other word classes in this respect. Notice that antonymy is central to the adjective category (Jones et al., 2012). Therefore, it is not surprising that explicit contrast use has impact on the production of the adjective class as a whole. In other word classes antonym relations play a less prominent role. Hence, it might be expected that in non-adjectival word classes only production of specific semantic groups is related to explicit contrast use. For instance, it is possible that only growth in the use of relational nouns (e.g. part names, kinship terms, spatial nouns) is influenced by explicit contrast use and not changes in overall noun frequencies. It is also reasonable to assume that young language

learners may benefit from opposites that are not confined to the same part of speech, but establish contrastive relations between words that belong to different grammatical classes from an adult point of view.

We close this article with a methodological remark. Longitudinal studies of spontaneous CS – which are predominantly case studies of individual children – usually investigate the development of linguistic phenomena by dividing the period under study into several (often arbitrarily defined) phases such as trimesters. In this article, we used a method which is much more suitable for longitudinal research and leads to more accurate results – a growth curve analysis by means of a multilevel logistic regression (cf. Van Veen, Evers-Vermeul, Sanders, & Van den Bergh, 2009). This method allowed us to model the development of adjective use over time at the same time keeping track of individual differences between children. We are convinced that the growth curve analysis has a great potential to provide valuable insights into the acquisition of various language phenomena, in the adjectival domain and beyond.

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