

*Wanna* Contraction in Typical Children and People with Williams Syndrome

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## Abstract

'*Wanna* contraction' has played an important role in debates about nativism and learning, partly because of evidence suggesting that children's use of *wanna* is adultlike by age 3 years. Using elicited production, we investigated whether 21 young people with Williams Syndrome (WS, age 8–17 years) and 13 adults with WS restrict their production of *wanna* in an adultlike way or in an atypical way, in order to address claims that language develops atypically in this population. We also tested 21 typically developing (TD) children (age 3;7–7;2) and 19 TD adults. The young WS group performed exactly as expected for their mental age, contrary to expectations of atypical development. Importantly, however, both they and the TD children produced *wanna* in illicit contexts. The adult results suggest that TD children eventually stop producing *wanna* violations, while WS children do not. The surprising production of *wanna* violations by TD children was replicated in a second study. These findings highlight the need for a learning account of *wanna* contraction that could explain how children normally recover from this error, and why people with WS do not.

## 1. Introduction

Certain aspects of grammatical knowledge seem to provide a particularly good testing ground for claims about nativism and learning that are relevant to theories of language acquisition. One such example concerns a phenomenon in English known as ‘*wanna* contraction.’ This refers to the phonological contraction of the main verb *want* and an adjacent infinitival *to*, resulting in the reduced form *wanna* (e.g. “I want to go” can also be pronounced “I wanna go”). It has been claimed that children must innately know that contraction will be blocked in certain syntactic contexts (Chomsky, 1980). Indeed, it has been suggested that if children had to learn where *wanna* contraction is blocked, the learning task would likely be impossible (Chomsky, 1980; Crain & Pietroski, 2001). Consistent with this expectation, previous empirical work has suggested that children already look adultlike in this domain of language from the earliest age that they can be tested—about age 3 years (Thornton, 1990, also reported in Crain & Thornton, 1998).

Certain populations are also sometimes looked upon as potentially providing a unique source of evidence bearing on theoretical debates regarding language acquisition. One such population that has played a role in such debates during the past 25 years is Williams syndrome (WS), a multi-system disorder that is associated with mental retardation. Representatives of two theoretical perspectives—nativism and neuroconstructivism—have each argued that WS provides evidence to support their opposing views. On the one hand, initial reports of WS seemed to raise the enticing possibility that a person could be severely mentally handicapped with minimal impact on language (Bellugi, Marks, Bihrlé, & Sabo, 1988). This apparent language-cognition dissociation was taken as evidence to bolster the view that language is a specialized system or ‘module’ (Fodor, 1983). In more recent years, some reports of atypicality in language development in young children with WS (reviewed in Thomas & Karmiloff-Smith, 2003) have been taken to support a ‘neuroconstructivist’ account of language. According to neuroconstructivism, neither the language system as a whole nor specific linguistic constructs can be selectively ‘spared’ since these are emergent properties of development; children with neurodevelopmental disorders like WS have

atypical brains that necessarily interact with language input in an atypical way, and thus their emerging language systems are expected to be abnormal. In a recent review of empirical work on WS language over the past 15 years, Brock (2006) concluded that the empirical basis for both of these claims about the theoretical significance of WS has been weak at best. First, language abilities in people with WS do not exceed expectations based on overall mental age. That is, the dissociation between language and cognition in people with WS is no more striking than that observed for typically developing children. Second, despite some evidence for atypical patterns in language development in very young children with WS, most of the research conducted on participants from late childhood onward has demonstrated that language in people with WS looks quite typical with respect to overall mental age (see Mervis, Robinson, Rowe, Becerra, and Klein-Tasman, 2003 for another review with similar conclusions).

It is surprising, in light of the recognized role of WS in these debates, that very few language abilities that have been argued to be innate have been examined in people with WS. In this paper we examine *wanna* contraction in a group of young people with WS (age 8-17) and a group of adults with WS (age 21-50). If young people with WS look adultlike in this domain of language, as do their mental age matched peers, then either they have the same innate knowledge as typically developing children (if indeed the knowledge is innate), or they have managed to solve the same difficult learning problem as typically developing children (if the knowledge is learned). In either case, this finding would be inconsistent with predictions about atypicality in WS language. If young people with WS make errors, producing *wanna* in illicit contexts, then this would suggest either that they do not have the same innate knowledge as typically developing children (if indeed the knowledge is innate), or it would suggest that they have not managed to solve the learning problem in a normal way (if the knowledge is learned). In either case, this finding would be consistent with the predictions of the neuroconstructivist view. Importantly, if young people with WS do make errors in their production of *wanna*, it is particularly interesting to know whether the older WS group looks adultlike or whether they too make errors, since it has been suggested that

the proper distribution of *wanna* contraction could not be learned. Errors made by either WS group could also be informative about how learning has gone wrong. For example, *wanna* could be produced in an unconstrained fashion, or it could be constrained based on a superficial generalization that is observed in the input (see sections 3.3 and 3.4). The latter finding would be consistent with the neuroconstructivist prediction that people with WS will interact with input in an atypical way.

The surprising finding of the research that we report here is that, although the young people with WS do perform in a completely typical manner for their mental age, neither they nor the younger typically developing children have reached the adult end state. Both groups produce *wanna* in illicit contexts, contrary to previous findings from non-disordered children and contrary to predictions based on learnability considerations. Taken at face value, this means that this is an area of linguistic knowledge that must be learned. Results from the adult groups suggest that people with WS ultimately fail at this learning task, while typically developing children ultimately succeed. We believe that by studying cases of developmental ‘stalling’ like this, in which people with mental retardation continue to make errors that non-disordered children usually overcome, we can begin to understand pre-requisites for reaching the end state of grammatical development.

Following a brief overview of WS, the grammatical phenomenon of *wanna* contraction is discussed in detail, along with a review of previous experimental work on its development and an analysis of a corpus of adult input containing *want to* and *wanna*. Two studies of *wanna* contraction are then reported, concluding with discussion of the findings and their implications for theories of learning and language acquisition.

## 2. Williams Syndrome Review

### 2.1 General Background

WS is a neurodevelopmental disorder caused by the hemizygous microdeletion of at least 19 genes on the long arm of Chromosome 7 (Hillier et al., 2003; Osborne et al., 2001). The estimated incidence (recently updated) is 1 in 7,500 live births (Stromme, Bjornstad & Ramstad, 2002). The deletion is associated with connective tissue abnormalities, cardiovascular disease, delayed development, a specific cognitive profile, and a unique personality (Morris & Mervis, 1999). Cognitively, WS is typically associated with mental retardation. Intelligence levels as measured by full scale IQ tests are typically in the mild mental retardation range (i.e. 50-70), but there is uneven performance across sub-tests of intelligence tests. Verbal IQs are typically slightly but reliably higher than non-verbal IQs, while Spatial IQs are considerably lower than either (Morris and Mervis, 1999). For example, in one study of 50 children and adolescents with WS (age 7;0 to 16;11) using the Differential Abilities Scale (Elliot, 1990), the mean verbal IQ was 70 (range 51-100), the mean non-verbal IQ was 67 (range 52-98), and the mean spatial IQ was 55 (range 50-79). Nearly identical means were found for the verbal and non-verbal subtests of the KBIT (Kaufman Brief Intelligence Test, Kaufman & Kaufman, 1990) for a group of 250 people WS individuals that included adults (Mervis, Robinson, Rowe, Becerra, and Klein-Tasman, 2003).

### 2.2. Expressive Language in Williams Syndrome

In early language development, first words and first productive word combinations are usually delayed—sometimes substantially—in children with WS (Mervis, Robinson, Rowe, Becerra & Klein-Tasman, 2003). For example, WS children, on average, attain a vocabulary of 10 words by age 28 months, compared to 12-13 months for typically developing children (Mervis et. al. 2003). First productive word combinations for a group of 7 WS

children who were followed longitudinally occurred between 26 months and 50 months (Mervis et al., 1995). The emergence of grammatical morphology, like the emergence of vocabulary and first word combinations, is delayed in children with WS, but once it emerges, development proceeds at a normal rate (Mervis et al., 1995). By late childhood grammatical morphology is usually very good for English speaking children with WS (Clahsen & Almazan, 1998), although there is evidence of greater difficulty with grammatical morphology for children with WS who speak morphologically richer languages such as Italian, Hebrew, and Hungarian (Levy & Hermon, 2003; Volterra, Capirci & Caselli, 2001; Lukács, Pléh & Racsmány, 2004). These problems have included a few reports of unusual errors made by Italian children with WS in the context of a sentence repetition task (Volterra, 1996; Capirci, Sabbadini & Volterra, 1996). Syntactic development is also delayed in people with WS, but most studies suggest that it follows the same course of development observed in typically developing children. For example, at 4 years of age children with WS use sentences of the same complexity as typically developing children who have similar sized vocabularies (Mervis, 2003). Furthermore, the relationship between length of sentences and syntactic complexity of sentences is developmentally normal in children with WS (Klein, 1995). Elicited production studies that examined relative clauses and affirmative and negative wh-questions have shown that children and adolescents with WS demonstrate knowledge of the syntactic form of these complex structures, and that those errors that they do make closely resemble errors made by typically developing children in similar contexts (Zukowski, 2001, 2004).

Controversy remains about whether language acquisition in WS is essentially normal or whether it is atypical, and only a relatively small number of grammatical phenomena have been investigated. Another open question concerns the endpoint of grammatical knowledge. It is not known whether adults with WS ever reach an adultlike level of knowledge and performance for those aspects of language that pose problems for them (and for normally developing children) at an earlier age.

### 3. *Wanna* contraction: Theoretical perspectives and empirical findings from typically developing children

#### 3.1 The Phenomenon and Three Theoretical Accounts of It

Sometimes when the English verb *want* is followed by the infinitival marker *to*, these two forms may be phonologically reduced to the form *wanna*. Examples of this phenomenon, known as *wanna* contraction, are given in (1). The underscore in each example indicates the ‘extraction site’ for each question.

- 1a. Who do you [want to, wanna] kiss \_ ?
- 1b. Who do you [want to, wanna] dive with \_ ?
- 1c. When do we [want to, wanna] have lunch \_ ?
- 1d. Why do they [want to, wanna] go home \_ ?

A curious contrast that has been acknowledged since at least 1970 (Lakoff) is that in some sentences that have a surface appearance very similar to that in (1), *wanna* contraction is not possible. Examples like this are shown in (2).

- 2a. Who do you [want \_ to, \*wanna] kiss you?
- 2b. Who do you [want \_ to, \*wanna] dive first?

One way of characterizing the empirical contrast shown above is that in *wh*-questions, *want* and an adjacent infinitival *to* cannot contract if the question queries the identity of the subject of the infinitival clause, as in (2), but they can contract if the question queries information about any other constituent in the infinitival clause, as in (1). Subject questions do not allow *wanna* contraction, while non-subject questions do. Another way of characterizing the empirical contrast shown above is that *want* and an adjacent infinitival *to* can contract if the subject of the *want* clause and the subject of the infinitival clause are the

same individual, as in (1), but they cannot contract if the subjects are different individuals, as in (2). These two different ways of characterizing the contrast correspond to two different classes of theoretical accounts of the phenomenon that have been debated for the past 3 decades. One class of accounts centers on a negative constraint that blocks contraction in certain environments. The other class focuses on a positive licensing generalization that dictates where contraction is allowed.

A prominent and influential example of a contraction blocking account is one that we will call the ‘wh-trace account.’ According to this account, *wanna* contraction is blocked whenever there is a phonetically empty trace of a wh-word located between the *want* and the infinitival *to* (Lightfoot, 1976, Chomsky, 1977; Chomsky & Lasnik, 1977; Rotenberg, 1978). This circumstance will occur whenever there is a main clause with the verb *want* taking an infinitival clause as its complement, and a question is formed which queries the identity of the subject of the infinitival clause. For example, *wanna* contraction is blocked in 2a) because, in the derivational history of this sentence, the word *who* originates in a position between *want* and *to* (e.g. You *want who* to kiss you); when the word *who* is extracted for movement to the front of the sentence, a trace of its presence is left behind in its original position. The sentences in (2) differ in this regard from those in (1); in each of these cases, the wh-word originated someplace other than between *want* and *to* (e.g. You *want to kiss who?*; You *want to dive with who?*). Contraction blocking accounts like this one are theoretically compelling to many people because they seem to provide naturalistic evidence for the ‘psychological reality’ of phonetically null syntactic constructs (e.g. wh-trace). However, such accounts have been criticized as lacking in ‘descriptive adequacy’, because they fail to account for contexts that disallow *wanna* contraction despite the absence of an intervening wh-trace (Postal & Pullum, 1982).

Postal and Pullum (1978, 1982) have argued that a positive licensing requirement for *wanna* contraction is more empirically justified than a negative constraint. According to their account, which we will call the ‘subject sharing’ account, *want* and *to* can contract

whenever the subject of the *want* clause and the subject of the infinitival clause are the same. This subject sharing condition is met in all of the sentences in (1). By contrast, the subject sharing condition is not met in the sentences in (2). This account has been criticized on the grounds that it requires special rules that are not independently theoretically justified (Chomsky & Lasnik, 1978). Nevertheless, the notion that subject sharing is a central feature of the licensing context for *wanna* contraction is bolstered by crosslinguistic evidence that has motivated a third account of *wanna* contraction.

A third account of *wanna* contraction is motivated by close parallels between contexts that license *wanna* contraction in English and contexts that license clitic climbing in languages containing clitics. Clitic climbing is a phenomenon in which an object clitic that is an argument of an infinitival verb in an embedded clause is attached to the main clause verb that takes the infinitive clause as its complement. This placement of object clitics is unusual because clitics normally attach only to the verb of which they are an argument. Examples are shown in (3) and (4), which are borrowed from Goodall (1991). Notice that in these examples the main clause verb is ‘want’. Among languages that exhibit clitic climbing (Italian, Spanish, Japanese, German, Dutch and others), ‘want’ is universally one of the sentential-complement-taking verbs that allows clitic climbing (Wurmbrand, 1998).

3. Lo voglio leggere (Italian)

it I-want read (infinitive)

‘I want to read it’

4. Lo quiero leer (Spanish)

it I-want read (infinitive)

‘I want to read it’

Rizzi (1982) and others (e.g. Roberts, 1997) have interpreted clitic climbing as evidence that the main clause and the infinitival clause have ‘restructured’ into a single clause with a

single subject. Goodall (1991) argues that the same restructuring operation occurs in similar contexts in English, and that *wanna* contraction is parasitic on reconstruction (Goodall notes that this possibility was first suggested by Frantz, 1977 and Pullum, 1982). Besides the fact that clitic climbing and *wanna* contraction both occur with the main verb *want*, other parallels include the requirement that the embedded clause be infinitival, and the requirement that the subject of the higher and lower verb be the same (Goodall, 1991). Thus, the restructuring account of *wanna* contraction and the subject sharing account of *wanna* contraction are similar in two ways: both posit a positive licensing condition, and both recognize subject sharing as central to the licensing context. Note that if subject sharing is indeed a prerequisite for *wanna* contraction, the wh-trace constraint is unnecessary because it does no additional work. That is, a wh-trace can only occur between *want* and infinitival *to* when the subjects of the *want* clause and the infinitival clause are different.

Irrespective of the question of which of these theoretical accounts is correct, the surface similarity between sentence pairs like 1a) and 2a) might invite young learners to draw the incorrect inference that since *wanna* contraction is possible in environments like (1), it is also possible in environments like (2). A surprising finding, which we turn to next, is that young, typically developing children do not appear to draw this incorrect inference.

### 3.2 *Wanna* Contraction in Typically Developing Children

Typically developing children have been shown to resemble adults in their *wanna* contraction behavior from the earliest ages tested (age 3;6). Thornton (1990, also reported in Crain & Thornton, 1998) elicited wh-questions from young children by having them address questions to a puppet who was said to be too shy to talk to grown-ups. Children were led to produce both subject and object questions by listening to whispered prompts from an experimenter. For example, to elicit an object question, a child might be told “The rat looks kind of hungry. I bet he wants to eat something. Ask him what.” (Crain and

Thornton, 1998, p. 181). The prompts themselves never contained the sequence *want to*, and therefore they did not provide a model of either *wanna* contraction or avoidance of *wanna* contraction. Results from 14 children (age 3;6 to 5;5) showed apparently adult like knowledge of *wanna* contraction. Among the 68 object questions produced, 60 (88%) showed contraction. By contrast, among the 74 subject questions produced, 68 (92%) had no contraction. These impressive results prompted the conclusion that the knowledge that wh-traces block contraction may be innate (Crain & Thornton, 1998). This study is widely believed by those working within a generativist framework to provide evidence for this conclusion.

### 3.3 The Input

According to at least one account of *wanna* contraction (the wh-trace account), children do not need to learn where contraction is prohibited (i.e. across a wh-trace) because this is part of their innate knowledge about language. Whether this is correct or not, it is possible that children with WS do need to learn where contraction is prohibited, since it cannot be taken for granted that they have a similar initial state as typically developing children. Given that learning may be required, at least for people with WS, we undertook an analysis of input to children. The goal was twofold: to determine the distributional facts about *wanna* contraction in questions in the input, and to use this information to provide suggestions about how a learner might misanalyze the data. The analysis suggests that the input greatly underdetermines the generalization that English speakers seem to converge on.

We searched the English portion of the Childes database (MacWhinney, 2000) for all wh-questions produced by adults that contained *wanna* or the sequence *want to*. We examined all matching utterances by hand, and categorized them into subject questions (e.g. *Who do you want to drive the car?*) and non-subject questions (e.g. *Who do you want to speak to?*). With very few exceptions, the subject of the main clause in these questions was *you*. The results,

separated by extraction type (subject vs. non-subject) and wh-word (who, what, where, when, why) are shown in Table 1.<sup>1</sup>

Table 1. Occurrence of *wanna* and *want to* in wh-questions in adult speech from Childes

Wh-word	Subject Questions		Non-subject Questions	
	('Illicit' contexts)		('Licit' contexts)	
	Want to	Wanna	Want to	Wanna
What	0	1*	365	200
Who	9	2*	9	6
Where	na	na	88	31
When	na	na	1	2
Why	na	na	137	27

\*Note: these examples are predicted to be unacceptable, and yet they were produced by adult native English speakers. The three examples were “*What do you wanna go in our car?*”, produced by a mother, and “*Who do you wanna open it?*” and “*Who do you wanna help you?*”, both produced by the same investigator.

Table 1 shows that the input contains many examples of licit *wanna* contraction, and almost no examples of illicit *wanna* contraction. However, a serious deficit in the input is that adults produce very few *subject* questions of any type (*who* or *what*) with the relevant *want + infinitival to* sequence; only 12 such questions are produced by adults in the entire CHILDES database. These are precisely the question types in which contraction is illicit. If such questions were produced frequently, with very low rates of *wanna* contraction, this might potentially allow children to infer, by comparison to higher rates of *wanna* contraction in other question types, that contraction is illicit in just these contexts. That is, if such questions were produced, this could have provided children with a potential source of indirect negative evidence. The near absence in the input of subject questions with the

<sup>1</sup> For a very small number of questions, the extraction cite was ambiguous (e.g. *Who do you want to play?*), and these are not included in the results. Also excluded are a small number of search matches in which the extraction cite of the question lies outside of the complement of *want* (e.g. *What would you do if you had a kid who didn't want to eat them?*).

relevant *want-to* context complicates the learning problem in several ways for any child who might have to depend on input in order to learn the adult system. First, it means that there is no evidence that would prevent a child from drawing the incorrect generalization that *wanna* contraction is possible in subject questions. Second, if a child did draw this incorrect generalization, there is no evidence that could potentially alert the child to the mistake.

This analysis also reveals further deficiencies in the input. Whereas some types of rarely heard questions do not allow contraction (subject questions), other types of rarely heard questions do allow contraction (non-subject questions with *who* and *when*). In other words, the scarcity of the input hides both valid and invalid contexts for *wanna* contraction. If children treat these rarely heard questions differently in their own production of *wanna* contraction, this is clearly not a direct reflection of adult input, since the adult input is compatible with a number of different generalizations. Therefore, children's treatment of these questions can reveal something about the nature of their internal grammatical systems.

### 3.4 The current study

In light of these details about the unhelpfulness of input, the finding that children already resemble adults in their production and avoidance *wanna* contraction from the age of 3 is even more impressive. However, the details of the input also raise the possibility that the adultlike performance of young children seen in a previous study may not actually reflect an adultlike grammatical system. In Thornton (1990), type of wh-word was confounded with extraction type: non-subject questions were typically *what* questions, while subject questions were typically *who* questions. This is relevant because the input analysis demonstrates that children hear *wanna* contraction with *what* questions in the input, but they never hear *wanna* contraction with *who* questions, regardless of the extraction type. If, on the basis of input like this, children drew the conclusion that contraction is possible in

*what* questions but not in *who* questions, they would have performed in an adultlike manner in the previous study even while having a different underlying rule for *wanna* contraction. In light of this possible confound, it would be wise to seek to confirm Thornton's results for typically developing children with a design that crosses wh-word with question extraction type. Thus in addition to the primary goal of examining *wanna* contraction in people with WS, a secondary goal of this work was to determine more conclusively whether young typically developing children are adultlike in their production of *wanna* contraction. Experiment 1 crosses wh-word (*who* vs. *what*) with extraction type (subject vs. non-subject). *Where*, *when* and *why* questions will not be included, because they are confounded with extraction type (they are never subject questions).

The current study also deviates from previous work on *wanna* contraction in a second way, in order to remove another potential confound in the materials that were used. In Thornton (1990), non-subject questions were elicited using abbreviated (elided) questions that ended with the *wh*-word. This is illustrated in the excerpt described earlier, repeated in (1). However, many of the subject questions were prompted with elided questions that end with the word *wants*, as illustrated in (2) (cf. Thornton's 'complex protocol for eliciting subject extraction questions').

1) "The rat looks kind of hungry. I bet he wants to eat something. *Ask him what.*"

(Crain and Thornton, 1998, p. 181).

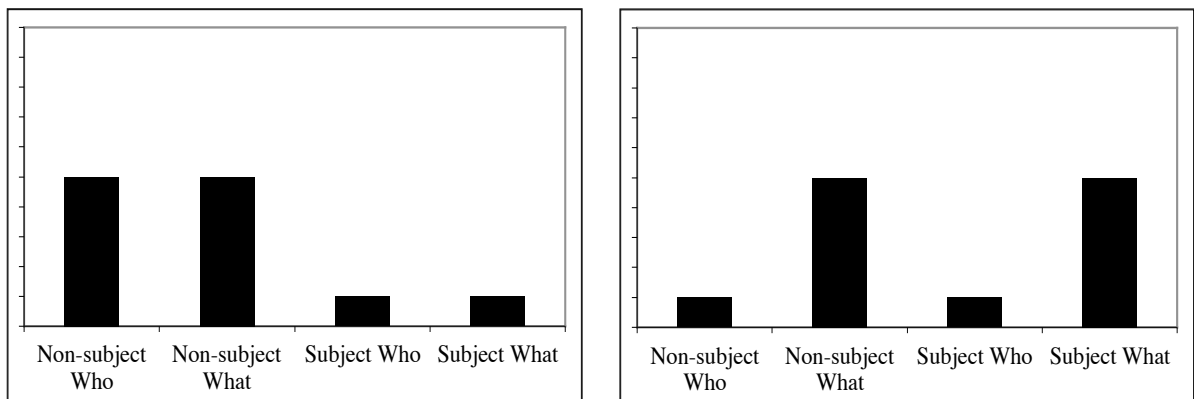
2) "In this game, there's a baby, a dog, and Cookie Monster, OK? And some different things are going to happen, and the rat gets to choose who gets to do different things. Now, one of these guys gets to take a walk, one of these guys gets to take a nap, and one of these guys gets to eat a cookie, right? Let's do the cookie first. So, one of these guys gets to eat a cookie, right? *Ask the rat who he wants.*" (Crain and Thornton, 1998, p. 182).

The subject/object asymmetry in prompt questions is potentially relevant to the interpretation of the results. In addition to the general concern that the two conditions should be optimally similar to each other apart from the extraction site of the target questions, there is a very particular concern that is raised by the form of the subject question prompts. Subject question prompts were elided after *wants*—that is, precisely at the location of the *wh*-trace, which is the construct that is thought to block contraction in adults (according to the *wh*-trace account). This feature of the subject question prompts could have artificially lowered children’s rates of contraction in subject questions (this possibility is explored further in section 4.3). In order to ensure that any asymmetry that might be observed in *wanna* contraction by the WS participants is not due to these differences between the critical experimental conditions, the prompts for all trials and all conditions will contain the full forms of embedded questions. To illustrate the difference, the full form of the prompts shown in (1) and (2) would be “Ask him what he wants to eat” and “Ask the rat who he wants to eat a cookie.”

Figure 1 shows a schematic representation of several patterns of *wanna* contraction that might be observed in Experiment 1. They each represent generalizations that a child might make based upon logical extensions of the input. The y axis represents rate of *wanna* contraction. A pattern like that in Figure 1a, where contraction rates are near zero for both types of subject questions (*who* and *what*), but high and similar for both types of non-subject questions, would implicate an adultlike structural generalization. A pattern like that in Figure 1b, where contraction rates are high and similar for both subject and non-subject *what* questions, and low and similar for both subject and non-subject *who* questions, would implicate a superficial generalization based incorrectly on *wh*-word. The pattern in Figure 1c closely matches the distributional evidence in the input: high rates of contraction in non-subject *what* questions, and low rates for the other 3 question types (because such questions are rarely attested in the input, either with or without contraction). We will call this an input matching pattern. Note, importantly, that in order for a learner to “match” the input in this way, she must already know that extraction type is relevant to *wanna*

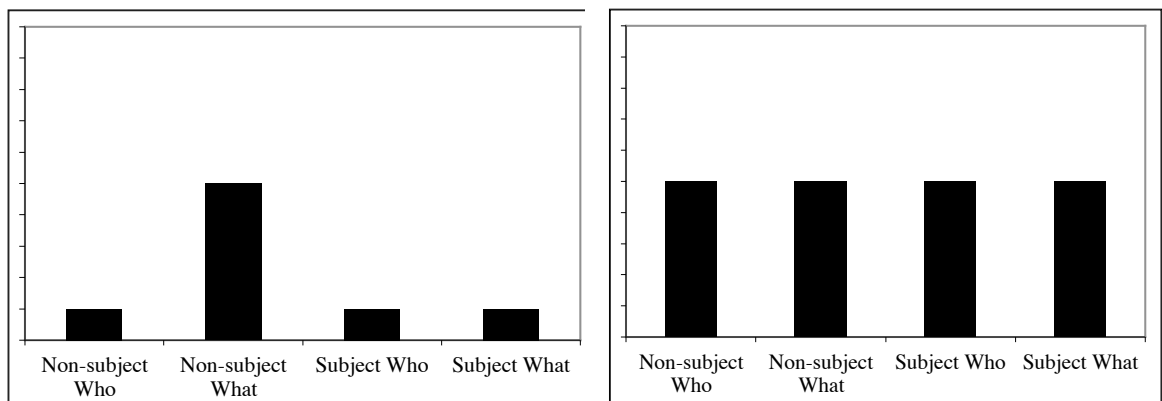
contraction. That is, achieving this pattern requires that the learner has taken note of both the *wh*-word and the extraction type of questions where *wanna* contraction has been heard. This would suggest that the learner is at some level aware that extraction site is important in conditioning *wanna* contraction. Finally, a pattern like that in Figure 1d, where contraction is observed at similar (non-zero) rates across the board, would implicate a broad overgeneralization.

Figure 1. Schematic representation of several possible patterns of *wanna* contraction



a. Adultlike Structural Generalization

b. Superficial Generalization



c. Input Matching

d. Broad Overgeneralization

The expected pattern of results for typically developing adults is that depicted in Figure 1a.

The main motivation for this research was to determine what the results would be for

children and adults with WS. If they achieve a pattern like that shown in Figure 1a, this would be evidence that they have drawn an adultlike structural generalization about contraction, which would contradict expectations of atypical language in people with WS. If they achieve a pattern like that shown in Figure 1b or 1d, this would be evidence that they have generalized beyond the input in a non-adultlike way. Whether this constitutes a typical or atypical generalization will depend on the results for the typically developing children. If the previous excellent performance of typically developing children truly reflects adultlike knowledge of *wanna* contraction, the control children should exhibit the pattern shown in Figure 1a, and their results should not differ from those of control adults. If, on the other hand, children in Thornton (1990) achieved an adultlike profile because of confounds present in the materials and methods used in that study, then we might observe a pattern like that shown in Figure 1b, 1c, or 1d.

## 4. Experiment 1

### 4.1 Method

#### 4.1.1 Participants

Participants in Experiment 1 were 21 typically developing (TD) children (age 3;7 to 7;2, mean = 5;2), 20 children and adolescents with WS (ages 8;9 to 17;6, mean = 12;10), 13 adults with WS (age 21 to 50, mean = 28;7), and 19 unimpaired adults. Typically developing children and unimpaired adults were all native speakers of English with no known learning disabilities who were attending school in Maryland. Participants in the WS groups had all been clinically diagnosed as having WS. Participants with WS were tested in one of several locations: in their homes, in the laboratory at the University of Maryland, or at the 2004 or 2006 Williams Syndrome Convention (the former in Grand Rapids, MI, the latter in Richmond, VA). TD children and children and adults with WS were administered

the KBIT (Kaufman Brief Intelligence Test, Kaufman & Kaufman, 1990). KBIT results from the participants with WS are shown in Table 1 (scores could not be obtained for a small number of participants; these are indicated in the table with a dash). Participant identities have been recoded with abbreviations of U.S. states. Table 1 gives both raw scores and standard scores from the verbal subtest and the non-verbal subtest (Matrices), as well as composite standard scores (note that age-based standard scores for the KBIT subtests have a mean of 100 and a standard deviation of 15)<sup>2</sup>.

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<sup>2</sup> An important note is in order regarding KBIT scores. The standard method of administering and scoring the KBIT dictates that older children and adults begin the test at a designated point somewhere in the middle, rather than item #1. If they then pass the first set of items administered to them, they continue forward, and it is assumed that they would have gotten every earlier item correct. We have found this assumption to be unwarranted for people with WS; the net effect is that, as they get older, their chronological age gives them free points that their abilities do not warrant. Since our primary purpose in collecting KBIT scores was so that we could fairly match WS participants to young typically developing 4–7 year old children (who always begin the test at item #1), we wanted to avoid unwarranted inflation of the WS scores. For this reason, we tested every participant from item #1 onward until ceiling was reached, and deducted points for every item answered incorrectly. The raw scores in Table 1 and their associated standard scores, reflect this alternative system of scoring (the exception is 5 WS adults, noted in Table 1 with a +. These latter 5 participants began the test at the designated starting point for their chronological age). For this reason, the standard scores in Table 1 cannot be considered comparable to those reported for people with WS in other studies. These scores would have been slightly higher for many subjects if the KBIT had been administered and scored in the standard way.

Table 1. Ages and KBIT scores of participants with WS

Code	Age	Raw Verbal	Raw Matrices	Standard Score Verbal	Standard Score Matrices	Standard Score Composite
DE*	8;9	29	15	75	72	71
KY	8;10	31	18	85	88	85
MI	9;0	43	18	92	74	81
AZ*	9;4	25	17	62	76	66
ME*	9;5	33	21	79	90	83
IA	9;11	23	10	54	45	45
AL*	10;4	44	24	96	95	95
CT	10;10	—	—	—	—	—
MH*	12;6	38	19	70	69	66
FL*	13;10	42	28	70	91	78
MO	14;2	34	15	47	40	40
MD	14;4	—	—	—	—	—
AK*	14;9	34	14	49	40	40
LA*	15;1	46	21	74	63	65
AR	15;6	—	—	—	—	—
MS	16;0	27	16	40	40	80
MT*	16;2	45	17	69	44	53
ID	16;3	37	23	79	40	56
HI*	16;5	49	20	77	56	63
MA*	17;6	39	28	55	82	65
NV+	21;4	49	19	74	55	61
NM+	21;7	40	11	78	79	76
KS	23;3	46	17	70	48	55
CA	25;6	37	20	56	65	56
GA	25;7	30	13	43	46	40
NJ+	27;8	55	21	84	68	74
MN	28;0	41	14	64	48	52
DC	28;3	55	28	84	84	82
NH+	33;2	64	27	97	82	88
IL	33;3	—	—	—	—	—
IN	35;7	50	17	79	61	67
CO	48;9	53	24	84	83	82
NE+	50;8	40	20	67	75	68

\*These 11 participants were matched to control children for the direct group comparison.

+These 5 adult participants were scored via the standard scoring method, and therefore both their raw and standard scores are inflated in comparison to other participants in this table. Since WS adults were not matched to controls, this does not affect comparability for our direct group comparison.

For purposes of direct group comparisons, a subgroup of WS individuals under age 18 were paired with TD control children with similar KBIT Matrices raw scores (the non-verbal subtest, which measures reasoning). Eleven WS–TD pairs were found who fit the criteria of having no more than 2 points difference in their Matrices raw scores. The 11 matched WS participants are marked in Table 1 with \*. A paired *t*-test confirmed that these two groups did not differ significantly in their raw Matrices scores,  $t(10) = -2.21, p > .05$  (for WS, mean = 20.4, for controls, mean = 20.9). It proved impractical to also match the groups on the Verbal subtest of the KBIT because this would have resulted in too few pairs to make the comparison meaningful. Thus the WS group achieved a significantly higher raw score than controls on the Verbal subtest (for the WS group, the mean was 38.5, for the control group, the mean was 31.3,  $t(10) = 3.66, p < .01$ ). However, it should be noted that the verbal subtest of the KBIT does not measure syntactic or phonological abilities. Rather, it assesses vocabulary knowledge and (for older children only) knowledge of the spellings of words.

#### 4.1.2 Materials and Procedure

An elicited production protocol was used to elicit *wh*-questions from participants. The materials and method were modified from Thornton (1990). Target questions varied in extraction type (subject vs. non-subject) and *wh*-word (*what* vs. *who*), resulting in 4 conditions. Non-subject questions queried either the direct object, an object of a preposition (e.g. Which school do you want to get into?), or the second object in a double object construction (e.g. What do you want to tell the students?). There were 5 target questions in each of the 4 conditions, yielding a total of 20 target questions per participant. The complete set of target questions is provided in Appendix A. The protocols used to elicit these questions can be found in Appendix B.

Participants were told to pretend they were on the set of a Harry Potter film, and that as part of this ‘game’ they would be asking some of the characters and the director some questions. They were then given a binder containing pictures representing different scenes from the movie. For each target question, the experimenter first described the scene depicted in one picture. She then prompted the participant to address a question about the scene to a character from the movie who was shown on a laptop computer screen. After the participant produced the question, the experimenter played a pre-recorded response by pressing a button on the computer. A sample protocol for eliciting a non-subject question is provided below.

Scene depicted in binder: Harry Potter and Hagrid in DiagonAlley

Character shown on Screen: Harry Potter

Experimenter protocol: “Here are Hagrid and Harry in DiagonAlley. Hagrid is helping Harry shop for his school supplies. Harry has a list of things he needs to buy. *Ask him what he wants to buy.*”

Target Question: What do you want to/wanna buy?

Prerecorded response: I need a cauldron, a broomstick, and a wand.

If the participant asked a question that did not contain *want* or that contained a truncated version of the target question (e.g. what do you want?), the experimenter would review the protocol and restate the critical prompt. Table 3 shows example question prompts and target questions for a subject question and a non-subject question. Note that the question prompts never contained the sequence *want to*, so the experimenter never modeled *wanna* contraction and never modeled clear enunciation of adjacent *want* and *to*. Although the sequence *wants to* does appear in the experimenter protocols, this sequence does not support contraction.

Table 3. Example question prompts and target questions

Extraction type	Question Prompt	Target Question
Subject Question	Ask Harry what he wants to fly into the room.	Harry, what do you want ___ to (*wanna) fly into the room?
Non-subject Question	Ask Hagrid what he wants to tell the students.	Hagrid, what do you want to (wanna) tell the students ___?

Responses from the WS groups and the TD child group were digitally recorded with a Marantz PMD 670 solid-state recorder. Responses from the control adults, who were tested earlier than the other groups, were recorded using a cassette tape recorder. Questions were transcribed and coded for the presence or absence of *wanna* contraction by one experimenter. To test for reliability of coding and to control for bias in coding, a sampling of the recordings of participant responses were digitally clipped so that they only contained the string {*what/who*} *do you* {*wanna/want to*}. Because the responses were clipped in the middle, it was not possible to tell whether they had occurred in a subject question or a non-subject question. Eight responses were clipped from each of 15 WS participants and 11 TD children, which represents more than half of the participants in these groups. For each participant, the first 4 examples that had been coded as containing *wanna* and the first 4 examples that had been coded as containing *want to* were included in the reliability test. For participants who produced fewer than 4 examples of each type, extra examples of the more abundant form were selected, so that a total of 8 examples from each selected participant were included. An independent rater blindly coded the 208 clipped sound files. Agreement rates between the two raters were high for the TD children and individuals with WS (93.2% and 94.17% respectively). A similar analysis for control adults was not performed because their data were not in digital form, however there is no reason to suspect that coding agreement would be any less consistent for adult responses.

## 4.2 Results

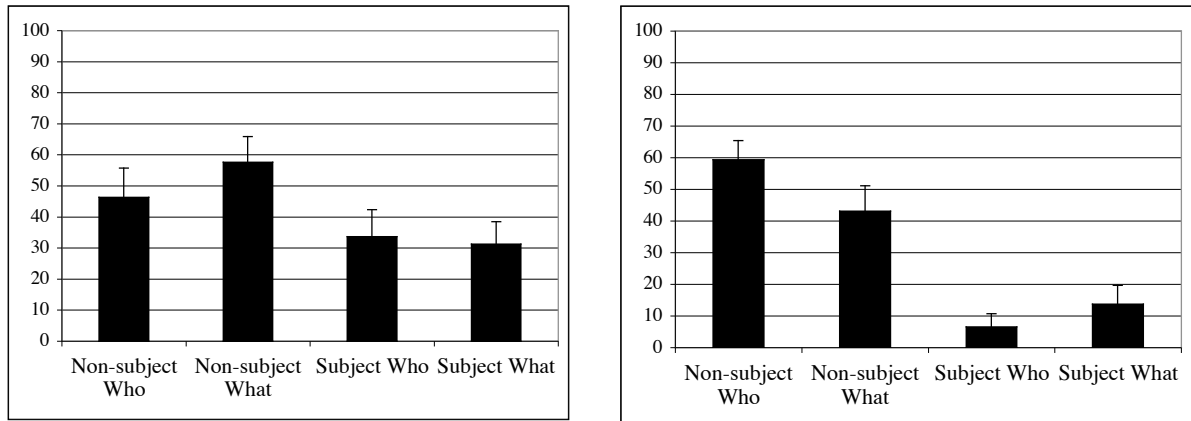
Participants who failed to contract even once throughout the experiment ('non-contracters') are not included in any of the analyses reported here. In total 8 participants failed to contract even once: 3 WS individuals under age 18, 2 WS adults, 2 TD children, and 1 TD adult. Results from the remaining participants (17 WS individuals under age 18, 11 WS adults, 19 TD children, and 16 TD adults) are examined below. In the results that follow, excluded from the data are the small number of responses where participants asked a question of a form that did not contain an adjacent *want* and infinitival *to* (e.g. 'What would you like to make?', instead of 'What do you want to make?'). This exclusion resulted in the removal of 13 responses from TD adults, 11 from TD children, 17 from WS under 18, and 3 from WS adults.

### 4.2.1 Group Results

Figure 2 shows mean rates of *wanna* contraction as a function of extraction type and wh-word for the 4 participant groups. The figure suggests that for all 4 groups, the overall pattern of performance most closely resembles the predicted pattern of the "Adult Structural Generalization": rates of *wanna* contraction were higher in non-subject questions than in subject questions. However, the rate of supposedly illicit *wanna* contraction (i.e. in subject questions) is higher than expected for all of the groups except the TD adults. While TD adults contracted in only 10.2% of subject questions (collapsing across wh-word), this figure exceeded 25% for every other group.

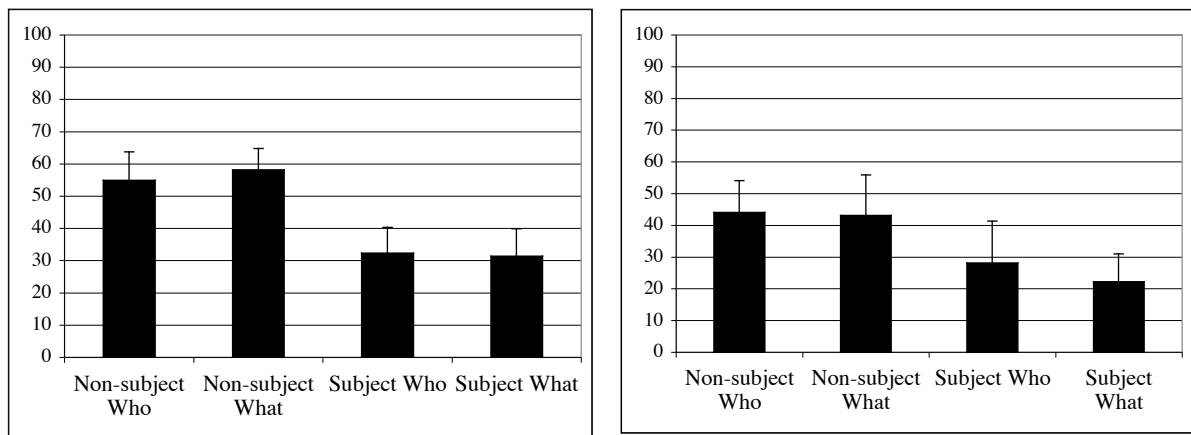
To verify these impressionistic patterns, two sets of analyses were performed. First, each group was examined independently to determine which of the patterns outlined in section 3.4 was statistically confirmed. Second, three groups were directly compared to each other: TD adults, TD children, and WS age 8-18, using just the 11 matched participants in the latter two groups. Adults with WS were not included in this analysis due to the enormous chronological age difference this group would have relative to TD children matched for mental age (see Mervis & Robinson, 1999 for discussion of this issue).

Figure 2. Mean rates of *wanna* contraction in Experiment 1



a. TD Children (n = 19)

b. TD Adults (n = 16)



c. WS 8-18 (n = 17)

d. WS Adults (n = 11)

For each of the 4 groups examined individually, there was a main effect of extraction type, with higher rates of *wanna* contraction in non-subject questions than subject questions. For TD children,  $F(1,18) = 14.1$ ,  $p < .001$ ; for WS under 18,  $F(1,16) = 13.3$ ,  $p < .001$ ; for WS adults,  $F(1,10) = 31.3$ ,  $p < .001$ ; for TD adults,  $F(1,15) = 60.3$ ,  $p < .001$ . Consistent with the impression given by Figure 3, none of the four groups examined individually demonstrated a main effect of wh-word. There was no interaction observed between extraction type and wh-word for either of the WS groups. However, results from both of the TD groups did show an interaction between these factors: for TD children,  $F(1, 18) = 4.7$ ,  $p < .05$ , and for TD adults,  $F(1,15) = 10.9$ ,  $p < .005$ . For both TD groups, Scheffé post hoc tests showed that wh-word modulated rates of *wanna* contraction in the non-subject

condition, but not in the subject condition. However, the effect of wh-word in the non-subject condition was opposite for children vs. adults: TD children contracted significantly more often with non-subject *what* questions (57.6%) than with non-subject *who* questions (46.3%), while adults did the opposite (43.1% contraction with non-subject *what* questions, compared to 59.4% contraction with non-subject *who* questions).

For the direct group comparison, results from 3 groups were submitted to a 3 x 2 x 2 mixed design ANOVA. Participant group (TD adults and the matched subset of TD children and WS under 18) served as the between-subjects variable, while extraction type (subject versus non-subject) and wh-word (*who* vs. *what*) served as the within-subjects variables. The results demonstrated a main effect of extraction type, due to higher mean rates of contraction in non-subject questions than in subject questions ( $F(1, 35) = 48.0, p < .001$ ). The test failed to demonstrate a main effect for either group ( $F(2,35) = 2.03$ ) or wh-word ( $F(1,35) < 1$ ). However, a group by extraction type interaction was driven by higher rates of contraction with subject questions (but not non-subject questions) for TD children and WS under 18 compared to TD adults ( $F(2, 35) = 4.4, p < .05$ ; Scheffé post hoc test between TD adults and TD children, significant at  $p < .001$ , and between TD adults and WS under 18, significant at  $p < .05$ ; the TD children and WS under 18 groups did not differ from each other). There was no overall interaction between wh-word and extraction type, however a 3-way interaction between wh-word, extraction type and group ( $F(2,35) = 4.2, p < .05$ ) was driven by the fact that TD adults, but neither of the other 2 groups, showed modulated contraction as a function of wh-word in the non-subject condition, but not in the subject condition (Scheffé post hoc test significant at  $p < .05$ ).

#### 4.2.2 Individual Results

The results above showed that all of the groups contract more often with subject questions than with non-subject questions, suggesting some sensitivity to the adult pattern. However, TD adults almost never contracted in ‘illicit’ contexts (subject questions), while participants in the other three groups did so significantly more often. However, group means may

obscure more interesting individual patterns. It is possible that there are children or adults whose individual patterns of performance suggest qualitatively non-adultlike generalizations about possible environments for *wanna* contraction. It is also possible that even among the that groups that failed to categorically disallow contraction in subject questions, there are individual participants who did show this more categorical adultlike pattern. To assess these possibilities, we examined individual patterns of contraction behavior.

Regarding the question of how many participants showed adultlike categorical performance, Table 4 shows the number of participants in each group who made different numbers of *wanna* contraction violations (i.e. contractions in subject questions). The final column shows the number of participants whose rate of *wanna* contraction was so sparse in the experiment (only 1 or 2 total instances of contraction) that the number of *wanna* violations they each made (0 violations for 15 of these 17 participants, and 1 violation for 2 of them) is not very informative.

Table 4. Counts of *Wanna* Violations Among Individuals

Group	Number of Violations			Data too Sparse
	0 or 1	2	3 or more	
TD Adults	12	0	2	2
TD Children	2	2	9	6
WS Young	3	2	9	3
WS Adults	1	0	4	6

Setting these participants aside, Table 4 shows that most TD adults (12/14, or 86%) made 0 or just 1 violation. These results contrast sharply with those for all three remaining groups, where the percentage of participants who made 0 or just 1 violation was 21% or lower (for the TD children, 2/13 or 15%, for WS young group, 3/14 or 21%, and for the

WS adult group, 1/5 or 20%). By contrast, the percentage of participants in these three groups who made 3 or more *wanna* violations was 64% or higher (for the TD children, 9/13 or 69%, for the WS young group, 9/14 or 64%, and for the WS adult group, 4/5 or 80%). In sum, there are very few children in the 3–7 year-old control group and very few participants with WS of any age who showed categorical or near-categorical avoidance of *wanna* violations in this task. By contrast, the majority of TD adults did.

In order to address the question of whether any individual children or WS participants showed evidence of having drawn a qualitatively non-adultlike generalization, bar graphs like those in Fig. 2 were made for each participant who contracted 3 or more times during the experiment. These bar graphs were examined for their resemblance to the patterns in Figure 1 (they are not included due to space limitations). No participant of any age, either with WS or not, showed evidence of having made a generalization based on *wh*-word. That is, no individual pattern resembled Figure 1b, despite the fact that this would be a reasonable conjecture on the basis of the input. Among the WS young group, 2 children had patterns suggesting a broad overgeneralization (as in Figure 1d), while none showed an input matching pattern (as in Figure 1c). Among the TD children, 2 had patterns suggesting a broad overgeneralization and 1 had a pattern resembling input matching. None of the WS adults showed either of these patterns. Of the remaining individuals in the TD child group and in the two WS groups, the majority had individual patterns resembling the group average (an asymmetry between subject and non-subject questions but no categorical avoidance of contraction in subject questions).

### 4.3 Discussion

The results of this study have shown that people with WS from at least age 8 years and onward, like typically developing children age 4-7 years, are similar to typically developing adults in several important ways. All of these groups contract *want* and an adjacent infinitival *to* more often in non-subject questions than in subject questions. None of the

groups tested, and likewise no individual tested, treated *who* questions and *what* questions systematically differently, despite the fact that the input analysis (section 3.3) showed that *wanna* contraction is regularly encountered with *what* questions, but almost never with *who* questions. This suggests that children and adults with WS are no more likely to generalize on the basis of this particular type of superficial category than are typically developing children and adults. However, the groups did differ on one very important measure: absolute rates of *wanna* contraction in supposedly illicit contexts (subject questions). On this measure, only TD adults performed as if their grammars include an absolute licensing condition such as a constraint on contraction over a *wh*-trace (only 10% violations). Higher violation rates in the other groups (25–30%) seem incommensurable with the claim that individuals in these groups have grammars with an absolute licensing condition.

Importantly, with respect to the question of whether language or language development is atypical in people with WS, all of the evidence reported here suggests that teens and pre-teens with WS perform in an absolutely typical manner relative to non-disordered children of the same mental age. Since both groups regularly produce *wanna* in illicit contexts, while non-disordered adults almost never do, this means that TD children and children and teenagers with WS face the same learning problem. The results from the two adult groups suggest that most people with WS never resolve this learning problem, while most typically developing children do. This pattern of typical but delayed and later arrested development has been observed for several other aspects of language in people with WS: errors in relative clause production (Zukowski, 2001, 2004), polarity in tag questions (Zukowski & Larsen, 2004), and errors in the form of negative questions (Zukowski, 2004).

If we wish to understand why people with WS never solve this learning problem, the necessary first step is to understand how typically developing children manage to do this. This question has not been addressed up until now, since the available data seemed to suggest that there was no learning problem—typically developing children already looked adultlike at age 3 (Thornton 1990). To the extent that the learning problem has been

discussed at all in the literature, the view that has been expressed is doubt about the possibility of learning the constraint on the basis of positive evidence in the input, as in this excerpt from Crain and Pietroski (2001): “If the grammars of English-speaking children lacked the constraint on contraction of *want* and *to*, then child English would include more sentences than adult English does. ... Non-nativists owe a learning account of how children could plausibly add such a constraint to a grammar that does not already incorporate it.” Given the empirical results observed here, a learning account of *wanna* contraction may be necessary regardless of one’s nativist status.

Because of the potential significance of our result with typically developing children for theories of language acquisition and learning, we conducted a second experiment with just typically developing children in which we sought to replicate our finding and to understand the discrepancy with previous work. If the finding is indeed replicated, we can return to the important question of how typically developing children could recover from the error, and why people with WS do not recover.

In order to identify some candidate explanations for the discrepancy between studies, we compared the method and materials used in Experiment 1 with those used in Thornton (1990). One difference between the studies can already be dismissed, because it was explicitly tested in Experiment 1: the confound in Thornton (1990) between *wh*-question and extraction cue does not account for why violations were so low in that study. However, a second confound in Thornton (1990) that was removed in Experiment 1 has the potential to account for the discrepancy in rates of violations in the two studies. As noted earlier, prompts in Thornton (1990) differed for the subject and non-subject questions. Non-subject question prompts were always elided after the *wh*-word (e.g. Ask him what), while subject question prompts were typically elided after the word *wants* (e.g. Ask him who he wants). We think it possible that the prompts used to elicit subject questions in this previous study might have led children to contract less frequently in this critical condition.

To see how, it is necessary to consider what happens when a child is prompted to produce a question.

In question elicitation, the embedded question in the experimenter's prompt is the last thing a child hears before initiating a response, and it is thus available to guide the response. For example, following a prompt like "Ask him what he wants to buy", the child's response need only transform the embedded question prompt into a main clause question ("What do you want to buy?"). In the case where an embedded question is elided, only the beginning of the child's response is guided by the embedded question. The remainder of the child's response is guided by information provided earlier in the experimenter's speech. In the subject condition in Thornton (1990), the experimenter would say something like "So one of these guys gets to take a walk, right? Ask the rat who he wants." In this case, the participant can follow the experimenter's lead and begin with "Who do you want...", but she then needs to 'fill in' the rest of the response using information from the experimenter's previous sentence. This means that there may be a natural break in sentence planning precisely between the word *want* and the word *to* in the subject condition—that is, precisely at the location of the wh-trace. If this is correct, then children could fail to contract *want* and *to* in this condition because of this shift in sentence planning, rather than because of the presence of the wh-trace and knowledge that wh-traces block contraction. In other words, rates of contraction in the subject condition may be artificially low because of this characteristic of the elided question prompts. A similar problem does not occur in the object question condition. Following a prompt like "I bet he wants to eat something. Ask him what", the participant can follow the experimenter's lead and begin with "Who..." In this case, the second part of the response, which has to be guided by information from earlier in the experimenter's speech, contains both the *want* and the *to*. In other words, although there may still be a natural pause in sentence planning in the object condition, this pause would not occur between the words *want* and *to*, and thus would not interfere with contraction.

Experiment 2 examines whether the difference in prompt types in Experiment 1 vs. Thornton (1990) might explain the discrepant results for typically developing children in these two studies. Experiment 2 directly compares the two types of prompts (Matched Full prompts vs. Mis-matched Elided prompts) within a single group of typically developing children. Experiment 2 did not examine participants with WS because their performance so closely paralleled the performance of the TD children in Experiment 1. The main unanswered question is why our results with typically developing children differed from those of Thornton (1990).

Two additional methodological changes were made in Experiment 2. First, since Experiment 1 demonstrated no main effect of *who* vs. *what* in children's *wanna* contraction behavior, Experiment 2 includes only *who* questions (both subject *who* questions and non-subject *who* questions). Second, in order to increase comparability with Thornton (1990), stories in Experiment 2 were enacted in front of participants using toys, and participants addressed their questions to one of the toy characters, which was manipulated and made to 'speak' by an experimenter. We suspect that some participants may have use a more formal speech register in Experiment 1 because they had to address their questions to a character depicted on a computer screen. This might explain why rates of *wanna* contraction in licit contexts was considerably lower in our study than in Thornton (1990).

## 5. Experiment 2

### 5.1 Method

#### 5.1.1 Participants

Participants in Experiment 2 were 18 children between the ages of 3;10 and 7;4. All children were native speakers of English with no known learning disabilities attending school or day care in Maryland. A subset of the participants (n = 8) had also participated in

the Experiment 1, several months prior to participating in Experiment 2. Where appropriate, their results will be considered separately.

### 5.1.2 Materials and Procedure

As in Experiment 1, an elicited production protocol was used to elicit subject and non-subject *wh*-questions that contained the sequence *want* + infinitival *to*. One experimenter used toys to act out a short story. At pre-determined points in the story, the child participant was instructed with a prompt to ask one of the toy characters a question. After the child asked the question a second experimenter played the part of the character and provided an answer. If the child asked a question that deviated from the target question in not containing an adjacent *want* and *to*, the first experimenter would repeat the question prompt. Sometimes the child asked a truncated question such as “Who?” or “Who do you want?” instead of the full target question such as “Who to you want to invite to your party?” In this case the second experimenter would first say, “Sorry?” or “Hmm?” and if necessary, would subsequently say “I’m sorry, I don’t know what you mean” and would then repeat the protocol and restate the prompt question.

Target questions varied in extraction type (Subject vs. Non-subject), and prompt type (Matched-Full vs. Mis-matched-Elided), resulting in 4 conditions that were tested using a within-subjects design. Each condition targeted 9 *wh*-questions for a total of 36 questions per participant. All of the target questions were *who* questions. In the Matched-Full prompt condition, the prompts all contained the full form of the embedded question. In the Mis-matched-Elided condition, the prompt for non-subject *wh*-questions was always “Ask him/her who,” and the prompt for subject questions was always “Ask him/her who she/he wants.” Thus, the cote of ellipsis was different for subject vs. non-subject questions, which replicates the method used in Thornton (1990). All of the stories designed to elicit subject *wh*-questions (regardless of prompt type) closely followed the ‘complex protocol for eliciting subject extraction questions’ used in Thornton (1990). The basic template involves

laying out several jobs or activities and designating one character who will get to choose which of the remaining characters will do each job. Below is an example story and question prompt for both the Matched-Full and Mis-matched-Elided conditions for trials targeting both Subject and Non-subject questions. See Appendix C for the full list of target questions and Appendix D for the full list of stories and question prompts.

### **Matched-Full Prompts**

Set Up:

In this game, there is a trainer at Sea World with a dolphin, a killer whale, and Nemo. The animals are all learning to follow instructions from the trainer, so they are waiting to hear what she wants them to do. One of them gets to jump through a hoop, one of them gets to eat some fish, and one of them gets to kiss a girl.

Subject Question Prompt:

So one of these animals gets to jump through a hoop, right? Ask the trainer *who she wants to jump through the hoop*.

Target Question:

Who do you want \_\_\_\_ to jump through the hoop?

(this is immediately followed by prompts that attempt to elicit ‘Who do you want to eat some fish?’ and ‘Who do you want to kiss a girl?’)

Non-Subject Question Prompt

Now the show is all finished. But there is still one fish left. The trainer wants to give it to one of these guys but I don't know who. Ask her *who she wants to give the last fish to*.

Target Question:

Who do you want to/ wanna give the last fish to \_\_\_\_?

### **Mis-matched-Elided Prompts**

Set Up:

In this story, a mom, a dad, and their son and daughter are going for a picnic. After they find a good spot in the shade by the lake, the mom starts to organize everyone. One person needs to spread out the blanket, one person needs to unpack the cooler, and one person needs to find the paper plates.

Subject Question Prompt:

So one person needs to unpack the cooler, right? Ask the mom *who she wants*.

Target Question:

Who do you want \_\_\_\_ to unpack the cooler?

(this is immediately followed by prompts that attempt to elicit ‘Who do you want to spread out the blanket?’ and ‘Who do you want to find the paper plates?’)

Non-subject Question Prompt:

The mom had such a great time that she has decided to have a picnic again next year. She wants to invite some other people next year. Ask her *who*.

Target Question:

Who do you want to/wanna invite to the picnic next year?

Trials with Mis-matched-Elided prompts formed 1 block of items, and trials with Matched-Full prompts formed another. Order of blocks was counterbalanced across participants. Within each block, prompts for target questions came in groups of 2 or 3 subject questions followed by 2 or 3 non-subject questions. This was necessary because the ‘complex protocol’ used in Thornton (1990) required that subject questions come in groups of 3. Within each block the stories and question prompts were always presented in the same order.

## 5.2 Results

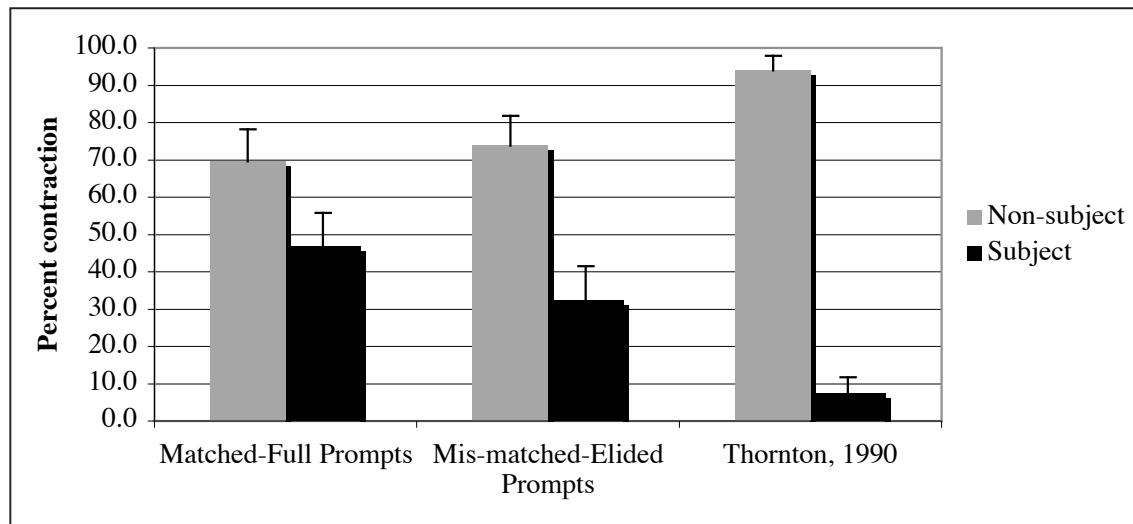
As in Experiment 1, data from children who never contracted are excluded from the results examined here. In this experiment, there were 2 children who never contracted, and thus only results from the remaining 16 participants are examined below. Also we excluded the small number of trials where participants asked a question that did not contain an adjacent *want* and infinitival *to*. There were only 13 such examples out of 576 total questions posed.

### 5.2.1 Group Results

Figure 3 shows rates of *wanna* contraction in Subject and Non-subject conditions as a function of prompt type (Matched-Full vs. Mismatched-Elided). Also included in Figure 3, for comparison, are results from Thornton (1990), whose prompts resembled those used in the Mismatched-Elided condition. Figure 3 shows that, overall, rates of contraction were higher in Experiment 2 than in Experiment 1. This can be seen most clearly by comparing the Matched-Full results in Figure 3 with the “non-subject who” and “subject who” bars in Figure 2a (recall that Experiment 2 used only *who* questions). For non-subject *who* questions, rates of contraction increased from 46.3% in Experiment 1 to 69.1% in Experiment 2. For subject *who* questions, rates of contraction increased from 33.7% in Experiment 1 to 47.1% in Experiment 2.

Figure 3 also shows that mean rates of *wanna* contraction in Non-subject questions in Experiment 2 did not vary as a function of prompt type. Rates of contraction were about 70% with both Full and Elided prompts. By contrast, rates of *wanna* contraction did vary as a function of prompt type in children’s subject questions: 32.3% contraction was observed with the Elided prompts, while 47.1% contraction was observed with Full prompts.

Figure 3. Mean rates of *wanna* contraction as a function of prompt type\*



\*In the Mis-matched-Elided condition, Subject prompts were elided after *wants*, and Non-subject prompts were elided after *who*.

In order to verify these results statistically, a 2 (extraction site) X 2 (prompt type) ANOVA was performed on rates of *wanna* contraction. There was a main effect of extraction type,  $F(1, 15) = 47.4, p < .001$  due to higher rates of contraction for Non-subject questions. There was no main effect of prompt type ( $F < 1$ ). Importantly, however, there was a significant interaction between extraction site and prompt type,  $F(1, 15) = 4.39, p = 0.05$ . Children were less likely to contract in the subject condition following prompts that were elided after the word *wants* than following prompts that were not elided (Scheffé post hoc

comparison significant at  $p < .05$ ), while children's contraction performance did not differ based on prompt type in the Non-subject condition.

Of the 16 people included in this analysis, 7 had also completed Experiment 1 (one additional participant from Experiment 1 was a non-contractor in Experiment 2). In order to examine the possible effects of prior participation, a second ANOVA was performed that added prior participation as a between-subjects factor. There was no main effect of prior participation ( $F < 1$ ), and there were no significant interactions involving the repeat factor. A third ANOVA examining the possible influence of Prompt Order (Elided prompt block first vs. Full prompt block first) failed to demonstrate a main effect for order, ( $F < 1$ ), and there were no significant interactions of order with either extraction site or prompt type.

Figure 3 shows that despite the reduced rates of illicit *wanna* contraction in the Mismatched-Elided condition compared to the Matched-Full condition, the results still contrast with the results of Thornton (1990). Compared to results from the Mismatched-Elided condition in Experiment 2, results from Thornton (1990) demonstrate both higher rates of contraction in non-subject questions and lower rates of contraction in subject questions. Results from an analysis of individual children suggest a more dramatic effect of prompt type, and a closer parallel with the results of Thornton's study, as shown in the next section.

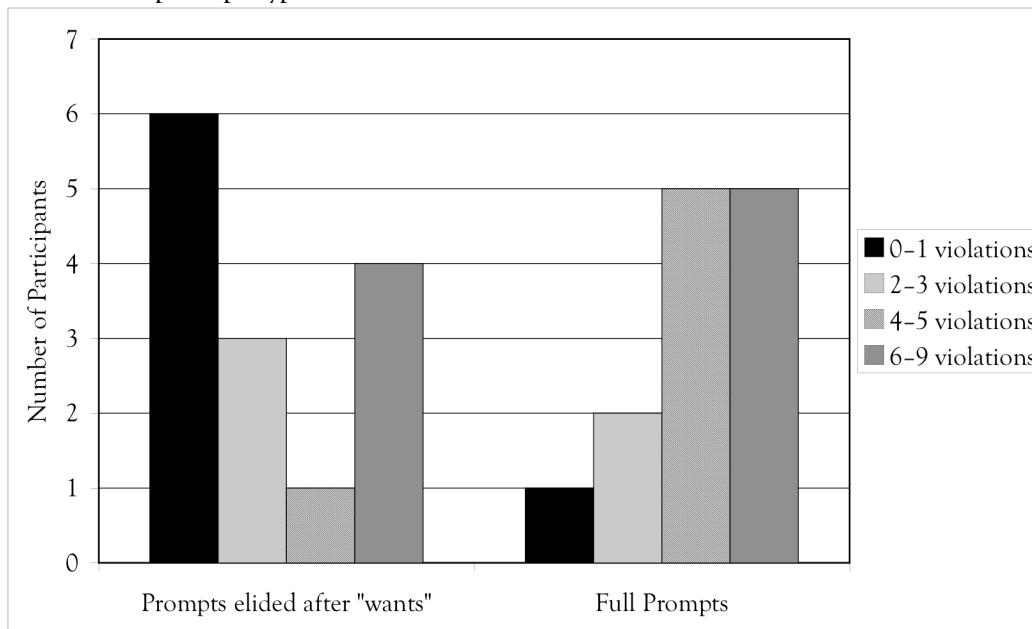
### 5.2.2 Individual Results

Figure 4 shows the number of participants who made different rates of *wanna* violations (i.e. contractions in subject questions) as a function of prompt type. In the Elided prompt condition, where prompts for subject questions ended precisely at the location of the wh-trace (e.g. Ask him who he wants) as they did for a portion of the subject questions in Thornton (1990), 6 children showed the adultlike pattern of almost complete avoidance of violations (either 0 or 1). In contrast, in the Full prompt condition, only 1 child showed

this pattern. In the Full prompt condition, most participants (10/13) produced 4 or more examples of illicit *wanna*.

Despite the overall high incidence of violations, the majority of participants included in Figure 4 (n = 11 in the Mis-matched-Elided condition, and n = 8 in the Matched-Full condition) contracted more often in licit contexts than illicit contexts (this is not shown in Figure 4). Each of these children produced at least 2 more examples of licit *wanna* than illicit *wanna*. All of the remaining participants (3 in the Matched-Full condition, and 5 in the Mis-matched-Elided condition) produced equivalent rates of licit and illicit *wanna*, where equivalent rates are defined as less than 1 token difference in either direction.

Figure 4. Number of participants who made different rates of *wanna* violations as a function of prompt type



### 5.3 Discussion

The results of the Matched-Full Prompt condition of Experiment 2 replicate the results of Experiment 1. Typically developing children age 4-7 do not strictly avoid *wanna*

contraction in subject questions (i.e. over a *wh*-trace), although they do contract less often in this context than in non-subject questions (about 20% less often in both studies). In fact, absolute rates of violations were even higher in Experiment 2 (about 47% in the Matched-Full condition of Experiment 2, compared to about 33% for control children in the subject-who condition of Experiment 1). This seems to be due to the fact that children contracted more often overall in Experiment 2 than in Experiment 1, possibly because in the previous study they had to address their questions to a computer screen, which may have led to a more formal speech register. The replication of the lack of strict avoidance of *wanna* contraction in subject questions heightens the need for a learning account that could explain how children could learn to avoid contracting in this context. We return to this issue in the general discussion section.

The results of Experiment 2 also show that the use of subject question prompts that are elided precisely at the location of the *wh*-trace (e.g. Ask him who he wants) lead to reduced rates of *wanna* contraction in children of this age range. If we take rates of contraction for subject and non-subject questions in the Full prompt condition as a baseline for children, rates of contraction with Elided subject prompts (like the one above) are reduced by nearly 15%, while rates with elided non-subject question prompts (like “Ask him what”) are not affected. These results suggest that we need to reexamine the results of previous research on *wanna* contraction that have used subject question prompts that were elided at the location of the *wh*-trace. Very low rates of *wanna* contraction in subject questions, rather than reflecting knowledge of the properties of *wh*-traces or the allowable contexts for *wanna* contraction, may partly be a methodological artifact.

Unfortunately, these results do not completely explain the discrepancy between Experiments 1 and 2 and Thornton (1990), because rates of violations were still quite high in the Elided subject condition of Experiment 2 (32%) relative to Thornton’s study (8%). At present, we can offer no additional explanation for this difference.

## 6. General Discussion

### 6.1 Implications for the Question of Typicality in WS Language

Experiment 1 showed that older children and adolescents with WS perform in a completely typical manner relative to non-disordered children of the same mental age in their production of *wanna*. Their similarity to typically developing children included both adultlike and non-adultlike features of performance.

Like non-disordered adults, rates of *wanna* contraction for both groups were contingent upon the extraction type of the question, and not on the identity of the wh-word. The lack of an effect of wh-word is relevant because wh-word did correlate strongly with the positive occurrence of *wanna* in questions addressed to children in our corpus analysis (where *wanna* contraction was regularly encountered in *what* questions but almost never in *who* questions, regardless of the extraction type of the question). The fact that people with WS were no more likely to be led astray by this superficial feature of the input than their typically developing peers runs counter to claims that people with WS learn language in an abnormal way. The other way in which the young WS group and the TD child group were similar to each other was that both groups produced *wanna* in illicit contexts substantially more often than TD adults. This was a completely unexpected finding for the TD children, since it contradicts previous research (Thornton, 1990), but high rates of violations were replicated in a second experiment.

The close similarity between the WS group and the TD child group in the use of *wanna* contraction adds to a growing literature demonstrating that “language as a whole in Williams syndrome is broadly in line with overall nonverbal mental age” (Brock, 2006). However, given that the typically developing child and the teenager with WS both allow *wanna* in illicit contexts, they both face the same learning problem: how to change their

grammars in such a way that these non-adult sentences are no longer generated. Our results from adults with and without WS suggest that typically developing children eventually succeed in this learning task, but children with WS do not. This is the only way in which people with WS have been shown to differ from their mental age matched peers in this domain of language, and the difference is important. Why do people with WS fail in this learning task? In order to address this question, we first need to know how typically developing children succeed. We address this question in the next section, after arguing that children's *wanna* violations do indeed reflect a non-adult feature of their grammars.

## 6.2 Implications for Language Development and Learning in Typically Developing Children

Although this research was designed to examine language in people with WS, the results for the typically developing children may be equally important because they contradict previous findings and, if taken at face value, they raise a challenging learning problem. In this discussion, we will first consider different ways of interpreting the fact that typically developing children contract in illicit contexts. We will then address the question of how children who violate the constraint at some point in development could come to eventually stop violating it.

How are we to interpret the fact that young children produce *wanna* violations? One possibility that it is important to consider is that these violations could be performance errors of some kind, rather than structures that are generated by young children's grammars. Is it possible that the procedures or materials used in our studies artificially induced apparent violations? We think this is unlikely. It is difficult to imagine that an experimental factor could induce children to violate a supposedly innate constraint regarding *wh*-traces, presuming that they correctly understand the structure of the questions that they are producing (i.e. they know where the *wh*-traces in their questions are situated). On the other hand, it seems more plausible that experimental factors could lead

to an artificial reduction in rates of *wanna* contraction in some contexts, and indeed Experiment 2 showed evidence of one experimental factor that had this effect.

Another possibility is that, although these violations are legitimately generated by young children's grammars, it is incorrect to assume that these children will grow up to resemble the typically developing adults from Experiment 1. That is, perhaps there recently been a language change wherein the innate constraint against contraction over a *wh*-trace is no longer part of the human endowment for language. We think this is unlikely. Only 15 years (less than a generation) separates the children tested in Thornton (1990) and the children tested in our studies. Likewise, the adults tested in Experiment 1 were only 12 to 17 years older than the typically developing children.

If it is correct that these violations are accurate reflections of the grammars of children who will eventually stop producing violations, there are two important implications. First, it substantially weakens the possibility that there is an innate constraint against contraction over a *wh*-trace. Second, it means that children are able to learn what constitutes an illicit context for *wanna* contraction, even though they pass through a stage when they do not know this. That is, children seem to overcome a subset-superset problem. The next section discusses how children could possibly achieve this.

In section 3.1, we discussed three theoretical accounts of *wanna* contraction: the *wh*-trace account, the subject sharing account, and the restructuring account. For this discussion we start from the assumption, motivated by our experimental findings, that young children do not yet know the licensing condition for *wanna* contraction. We also assume, based on our results from adults, that most young children will eventually successfully learn the licensing condition. We discuss each of these theoretical accounts in turn, focusing on the following questions. What evidence would a child require in order to learn the proposed licensing condition? In light of our input analysis, is that evidence likely to be available to children? Does the account predict successful learning of the licensing condition, something which

we know to occur? Where a proposed learning mechanism suggests a possible reason for the failure of adults with WS to solve the learning problem, this issue will be addressed.

According to the *wh*-trace account, *wanna* contraction is blocked whenever there is a phonetically empty trace of a *wh*-word located between the *want* and the adjacent infinitival *to*. Children's violations suggest that they freely contract over a *wh*-trace. In order to learn that this is wrong, children would need negative evidence of some kind. Direct negative evidence (someone directly telling children that they should have said "want to" in particular instances) could not possibly be available to all children, yet the majority of children successfully learn the proper distribution of *wanna*. Our analysis of the input also suggests that indirect negative evidence is not available to children. That is, children almost never hear the kinds of questions in which *wanna* contraction is illicit (e.g. Who do you want to win?), and therefore they do not have the opportunity to notice that adult rates of contraction in such questions differ drastically from rates of contraction in other types of questions. Thus, we agree with the view expressed by others that it is probably not possible to learn that there is a constraint on contraction over a *wh*-trace (Chomsky, 1980; Crain & Thornton, 1998; Crain & Pietroski, 2001). We believe that these issues raise important challenges for the *wh*-trace account of *wanna* contraction as a proper characterization of adult knowledge.

According to the subject sharing account, *wanna* contraction is licensed when the subjects of the higher verb and the lower infinitival verb are the same. One advantage of the subject sharing account over the *wh*-trace account is that the critical licensing feature (sharing of subjects) is readily observable in the input. However, this account also raises some important concerns. For instance, although the critical licensing feature (subject sharing) is observable in the input, children seem to have observed this feature already, as shown by the asymmetry in their rates of *wanna* contraction when subjects are shared (non-subject questions) vs. not (subject questions), yet children have crucially failed to draw the conclusion that subject sharing is a necessary feature of the context. Thus, successful

learning would require that children reanalyze subject sharing as a necessary requirement of the context for *wanna* contraction rather than as an accidental feature of the sentences in which *wanna* occurs. It is conceivable that children could be led to this reanalysis on the basis of positive evidence in the input. That is, although it is true that children will almost never have the opportunity to observe whether *wanna* contraction occurs in the absence of subject sharing (because children do not hear *want* + infinitival *to* questions with distinct subjects), it is nevertheless also true that every instance of *wanna* that children hear does involve a shared subject. Thus, the link between subject sharing and the occurrence of *wanna* contraction may become increasingly strong over time, which could result in a reanalysis of the status of subject sharing as a necessary feature of contexts for *wanna*. Therefore, the potential viability of this as a learning account may depend upon identifying a way to guarantee that children inevitably undergo this reanalysis of the status of subject sharing.

If subject sharing is an arbitrary condition on *wanna* contraction, it may be difficult to guarantee that children eventually reanalyze subject sharing as a necessary feature of contexts for *wanna* contraction. However, if subject sharing is necessary not for an arbitrary reason, but rather because it is a direct consequence of a monoclausal structure (which is the actual licensing feature), then children could become adultlike when they realize that sentences like “I want to go” are monoclausal. This brings us to the restructuring account.

According to the restructuring account, *wanna* contraction is licensed whenever *want* and *to* belong to the same clause as a result of restructuring (Goodall, 1991). For the purposes of this discussion, we will consider a simplified version of this licensing condition: *wanna* contraction is licensed whenever *want* and *to* belong to the same clause (whether as a result of derivational restructuring or not, a point that is debated in the theoretical literature on clitic climbing; see Wurmbrand, 1998 for discussion). An advantage of this account over the subject sharing account is that there is conceivably a natural relationship between the licensing condition and the phenomenon of contraction. That is, it makes sense that

contraction should be confined to occurring within a single clause rather than across a clause boundary. Given that young children produce *wanna* in contexts that are clearly biclausal (contexts where the *want* clause and the *to* clause have distinct subjects, as in “Who do you want to go?”), it is clear that they do not obey a monoclausal licensing condition. In order to become adultlike children would need to learn the monoclausal restriction on *wanna* contraction, which they might be pre-disposed to find plausible. One disadvantage of the restructuring account over the subject sharing account is that the critical licensing feature (that the *want* and the infinitival *to* be part of the same clause) is not readily observable in the input. That is, it is not obvious from the surface appearance of sentences like “Who do you want to find?” that they are monoclausal. One possible source of evidence could come from sentences containing expressions like *hafto*, *sposto*, *usto*, and *gonna*. These expressions, like *wanna*, have been analyzed as involving contraction of a verb with an infinitive *to* (have to, supposed to, used to, going to). If children know that sentences like “I hafto be there on Thursday” and “I usto be a good swimmer” contain instances of *to*-contraction (like *wanna*) and if they know that such sentences are monoclausal, this could lead children to reanalyze sentences containing *wanna* contraction as also being monoclausal. However, children may require exposure to written language in order to realize that sentences containing *hafto* and *usto* involve *to*-contraction and are monoclausal. This is because in spoken form, the *have* in *hafto* is never pronounced /hav/ or /haz/, but rather /haf/ or /has/; similarly, the *use* in *usto* is never pronounced /yuz/, but rather /yus/. It may be that children do not realize that these forms contain the common verb forms *have* and *use* until they see the written forms *have to* and *used to*, and it is only then that they may realize that these expressions have undergone contraction with *to*, which is responsible for their altered pronunciation. Recognition that *hafto* and *usto* contain *have* and *use* may also enable children to analyze sentences like these as monoclausal, because the meanings of *have to* and *used to* are not compositionally related to the meanings of *have* and *use*. If this is the source of evidence that children use to learn the proper distribution of *wanna* contraction, then it predicts that there should be a correlation between reading experience and avoidance of *wanna* violations. An account

based on evidence gained from reading experience also has the potential to explain the failure of some people with WS to learn the proper distribution of *wanna* into adulthood, since reading abilities are poor for many people with WS.

Although questions remain for all of these accounts, we think that a positive licensing condition, such as the subject sharing account or the restructuring account, has greater potential than a negative licensing condition to explain how children learn the proper distribution of *wanna*. We believe that the empirical results that we have reported in this paper motivate a careful consideration of learnability as a criteria for evaluating alternative theoretical accounts of adult intuitions about *wanna* contraction.

## 7. Conclusion

This study has shown that young people with WS show a mental-age appropriate pattern of performance in their production of the contracted expression *wanna*. This pattern includes both adultlike features of performance and non-adultlike features of performance. These findings support the claim that language in people with WS is commensurate with their overall mental age. Importantly, however, results from adults suggest that people with WS continue to produce *wanna* in illicit contexts into adulthood, while their non-disordered peers manage to overcome this developmentally normal error. The significance of this finding of developmental stalling in WS depends on how it is that non-disordered children recover from the error—a process that has never been explored before because it was believed that children do not make such errors. The surprising finding that typically developing children produce *wanna* in illicit contexts was replicated in a second experiment that identified one methodological factor that probably contributed to the apparent adultlike performance of children in a previous influential study (Thornton, 1990). These findings cast doubt on the claim that children are innately knowledgeable of a categorical constraint against contraction over a *wh*-trace, or indeed of any absolute licensing condition on the occurrence of *wanna*. The findings also suggest that it may be

commonplace for typically developing children to overcome a subset-superset problem. We have outlined one way in which children might achieve this, but the question is far from resolved.

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## Appendix A

### Experiment 1 Target Questions

#### Subject Questions with *Who*

1. Who do you want to see your scar?
2. Who do you want to make an announcement?
3. Who do you want to win the game?
4. Who do you want to win the fight?
5. Who do you want to play chess?

#### Subject Questions with *What*

1. What do you want to fly into the room?
2. What do you want to happen next?
3. What do you want to hit Harry?
4. What do you want to happen to Malfoy?
5. What animal do you want to rescue Harry?

#### Non-subject Questions with *Who*

1. Who do you want to find?
2. Who do you want to fire?
3. Who do you want to sneak past?
4. Who do you want to thank?
5. Who do you want to see?

#### Non-subject Questions with *What*

1. What do you want to tell the students?
2. What house do you want to get into?
3. What do you want to tell Harry?
4. What do you want to make?
5. What do you want to buy?

## Appendix B

### Experiment 1 Protocols

1. When Harry gets on the train, all the other students are so excited to see the famous Harry Potter. They have all heard about the scar he has on his forehead, and everyone wants to see it. But Harry only wants *some* people to see his scar. *Ask him who he wants to see his scar.* (Answer: Hermione and Ron)
2. This is their first night at Hogwarts, and there is a big feast. In this scene, someone is going to make an announcement. This is a picture of Chris Columbus—he's the director of the movie. *Ask the director who he wants to make an announcement.* (Answer: Hagrid)
3. After everyone saw how fast Harry could fly, he got signed up to play Quidditch for Gryffindor. Here they are beginning the first Quidditch game of the schoolyear. It's Gryffindor against Slitherin. Hagrid is watching the game from his hut. *Ask Hagrid who he wants to win the game.* (Answer: I want Gryffindor to win)
4. Oh no, it looks like Harry and Malfoy are at it again. I wonder who will win the fight. *Ask the director who he wants to win the fight.* (I want Malfoy to win this time)
5. Once they got past Fluffy, Harry, Ron, and Hermoine find another obstacle protecting the sorcerer's stone. One of them is going to have to play chess and win in order to get through this room. *Ask the director who he wants to play chess.* (Answer: I want Ron to play, because he's the best chess player)
6. After the announcement, everyone wonders what is going to fly into the room. Harry wants it to be his owl. But Malfoy has a different idea. *Ask Malfoy what he wants to fly into the room.* (Answer: A ghost)
7. Here, the new students are getting their first flying lesson. Neville Longbottom has an accident and has to go to the infirmary. The teacher tells everyone to stay put until she gets back. But I wonder what will happen next. *Ask the director what he wants to happen next.* (Answer: I want Malfoy to steal someone's hat, and then I want Harry to chase him on his broomstick. Then everyone will see how fast Harry can fly)
8. The Quidditch game is in full swing, and it is really exciting. There are lots of different balls flying around—bludgers, the quaffle, and the golden snitch. In this scene, something is going to hit Harry in the head. *Ask the director what he wants to hit Harry.* (Answer: A bludger)
9. Hermoine is fed up with Malfoy. She is getting ready to put a spell on him. *Ask Hermoine what she wants to happen to Malfoy.* (Answer: I want Malfoy to turn into a snake)
10. In this scene, Harry is in the dark forest, and Voldemort is going to attack him. The director has decided that a special animal is going to rescue Harry. *Ask the director what animal he wants to rescue Harry.* (Answer: A centaur)
11. Harry is getting ready to take the Hogwarts Express to school. He is on Platform nine and three-quarters, and he is looking for someone. *Ask him who he wants to find.* (Answer: I'm trying to find Hagrid)

12. These actors are always arguing. In fact the director wants to fire one of them. *Ask him who he wants to fire.* (Answer: I want to fire Professor Snape. He's always getting into trouble)
13. Harry and Ron are up to no good again. Harry has put on his invisibility cloak to sneak past someone. *Ask him who he wants to sneak past.* (Answer: We need to sneak past Fluffy, the 3-headed dog. She's guarding the Sorcerer's Stone)
14. Here are the actors that play Ron, Harry, and Hermione. They are appearing at an award ceremony. Harry wins an award, and he gets up to give his acceptance speech. There are a lot of people that he wants to thank. *Ask him who wants to thank most of all.* (Answer: I want to thank my parents, and my co-stars Ron and Hermione)
15. Quirrel and Harry are looking in the magic mirror. The mirror shows Harry that the Sorcerer's stone is in his pocket, but Quirrel can't see it. After Quirrel leaves, Harry keeps looking in the mirror. He wants to see someone. *Ask him who he wants to see.* (Answer: I just want to see my parents in the mirror again)
16. Oh, Hagrid is going to make an announcement. *Ask Hagrid what he wants to tell the students.* (Answer: Something is going to fly into the room, but don't be afraid!)
17. Wow! The sorting hat flew into the room! This hat tells you which house each student will be in (Gryffindor, Slytherin, Hufflepuff, and Ravenclaw). It's Harry's turn with the sorting hat. He really wants to get into one house and he is thinking very hard about that house. *Ask Harry what house he wants to get into.* (Answer: Gryffindor)
18. Hermione is mad at Harry in this scene and she looks like she is going to give him a piece of her mind. *Ask her what she is wants to tell Harry in this scene.* (Answer: I want to tell Harry that he has to stop breaking the rules, because Gryffindor loses points every time he does)
19. Hermione is very busy mixing a potion. *Ask her what she wants to make.* (Answer: a potion that allows me to go backwards in time)
20. Hagrid takes Harry to Diagon Alley to shop for his school supplies. Harry has a list of things he will need for school. *Ask him what he wants to buy.* (Answer: a broomstick, a cauldron, and a wand)

## Appendix C

### Experiment 2 Target Questions

#### Non-subject Questions Elicited with Full Prompts

1. Who do you want to take with you?
2. Who do you want to meet at the park?
3. Who do you want to tell about your trip?
4. Who do you want to give the last fish to?
5. Who do you want to invite to the show?
6. Who do you want have lunch with?
7. Who do you want to take a picture of?
8. Who do you want to send your picture to?
9. Who do you want to thank the most?

#### Non-subject Questions Elicited with Elided Prompts

1. Who do you want to put on your shoulders?
2. Who do you want to carry in your arms?
3. Who do you want to work out with?
4. Who do you want to give climbing lessons to?
5. Who do you want to give the chicken to?
6. Who do you want to go fishing with?
7. Who do you want to invite next year?
8. Who do you want make a cake for?
9. Who do you want to invite to the party?

#### Subject Questions Elicited with Full Prompts

1. Who do you want to jump through the hoop?
2. Who do you want to kiss the girl?
3. Who do you want to eat some fish?
4. Who do you want to dig the hole?
5. Who do you want to push the wheelbarrow?
6. Who do you want to plant the flowers?
7. Who do you want to watch for cars?
8. Who do you want to hold the stop sign?
9. Who do you want to hold the dog's leash?

#### Subject Questions Elicited with Elided Prompts

1. Who do you want to unpack the cooler?
2. Who do you want to spread out the blanket?
3. Who do you want to find the paper plates?
4. Who do you want to crack open the egg?
5. Who do you want to pour in the milk?
6. Who do you want to mix everything up?
7. Who do you want to scrub the dog?
8. Who do you want to dry the dog off?
9. Who do you want to brush the dog?

## Appendix D

### Experiment 2 Protocols

1. This man is going on a canoeing trip.
  - a. But he has a problem. He can't navigate and paddle at the same time. So he wants to take someone with him. *Ask him who he wants to take with him.*
  - b. The man is going to canoe all the way to the amusement park. He wants to meet someone there. *Ask the man who he wants to meet at the park.*
  - c. After their trip, the girl is so thrilled that she got to go canoeing to the amusement park. She wants to tell someone about her trip. *Ask her who she wants to tell about her trip.*
2. In this game, there is a trainer at SeaWorld with a dolphin, and killer whale, and Nemo. The animals are all learning to follow instructions from the trainer, so they are waiting to hear what she wants them to do. One of them gets to jump through a hoop, one of them gets to eat some fish, and one of them gets to kiss a girl.
  - a. So one of these animals gets to jump through a hoop, right? *Ask the trainer who she wants to jump through the hoop.*
  - b. So one of these animals gets to kiss the girl, right? *Ask the trainer who she wants to kiss the girl.*
  - c. So one of these animals gets to eat some fish, right? *Ask the trainer who she wants to eat some fish.*
  - d. Now the show is all finished. But there is still one fish left. The trainer wants to give it to one of these guys but I don't know who. *Ask her who she wants to give the last fish to.*
  - e. The trainer is really proud of everyone because they did such a great job. She is already looking forward to the next show. She wants to invite some people to the next show. *Ask her who she wants to invite to the show.*
  - f. The trainer is really hungry now and it's lunch time. She wants to have lunch with someone. *Ask her who she wants to have lunch with.*
3. In this story, Miss Piggy is doing some work in the garden with this cowboy, this man, and Dora.the Explorer. Miss Piggy doesn't like to get dirty, so she is going to ask her friends to help her. There are 3 jobs that need to be done, and Miss Piggy is going to choose who will do what. One of them needs to push the wheelbarrow, one of them needs to dig a hole, and one of them needs to plant a flower.
  - a. So one of the guys needs to dig the hole right? *Ask Miss Piggy who she wants to dig the hole.*
  - b. And one of the guys needs to push the wheelbarrow, right? *Ask Miss Piggy who she wants to push the wheelbarrow.*
  - c. So one of these guys needs to plant the flowers, right? *Ask Miss Piggy who she wants to plant the flowers.*
  - d. Miss Piggy has a special camera with her. Maybe she wants to take a picture of someone. *Ask her who she wants to take a picture of.*

- e. Oh really? Miss Piggy wants to send her picture to some people. *Ask her who she wants to send her picture to.*
  - f. Well, they are all finished working in the garden now. Miss Piggy is very grateful to everyone for helping. But she wants to thank one person the most. *Ask her who she wants to thank the most.*
4. In this game, there is a police officer, two boys, a girl, and a dog. They are at a crosswalk and the police officer needs some help so she can get everyone safely across the street. The children have agreed to help, and the police officer is going to tell everyone what their jobs are. One person needs to hold the stop sign, one person needs to hold the dog's leash, and one person needs to watch for cars.
- a. So one of these people has to watch for cars, right? *Ask the police officer who she wants to watch for cars.*
  - b. So one of these people has to hold the stop sign, right? *Ask the police officer who she wants to hold the stop sign.*
  - c. So one of these people has hold on to the dog, right? *Ask the police officer who she wants to hold on to the dog.*
5. This is Spiderman! He is so strong and he is such a great climber. Let's see if we can get him to do some superhero tricks for us. He is going to lift two of these people at the same time.
- a. He wants to put one of them on his shoulders. *Ask him who.*
  - b. Great. Now for the second one. He wants to carry one of these people in his arms. *Ask him who.*
  - c. Wow, he is so strong. But he is not able to lift 3 people at the same time yet. He needs to go work out more so that he can get stronger. He wants to work out with some other people. *Ask him who.*
  - d. Spiderman wants to give climbing lessons to someone. *Ask him who.*
6. In this story, a mom, a dad, and their son and daughter are going for a picnic. After they find a good spot in the shade by the lake, the mom starts to organize everyone. One person needs to spread out the blanket, one person needs to unpack the cooler, and one person needs to find the paper plates.
- a. So one person needs to unpack the cooler, right? *Ask the mom who she wants.*
  - b. And one person needs to spread out the blanket. *Ask the mom who she wants.*
  - c. And one person needs to find the paper plates. *Ask the mom who she wants.*
  - d. The mom has one plate of food ready . Everyone is really hungry, so she is going to give everyone a little bit from the plate. She doesn't like chicken herself, so she wants to give the chicken to someone else. *Ask her who.*
  - e. After everyone gets a bite to eat, the mom gets the gear ready to go fishing. She wants to go fishing with someone, but I don't know who. *Ask her who.*

- f. The mom had such a great time that she has decided to have a picnic again next year. She wants to invite some other people next year. *Ask her who.*
7. In this game there is a girl, Arthur, Tigger, and Bart Simpson, and all of them are at the girl's house.
- a. The girl wants to make a cake for somebody, but I don't know who. *Ask her who.*

Everyone wants to help make the cake and there are lots of jobs to do. Since this is the girls's kitchen, she is going to choose who gets to do what. One person needs to pour in the milk, one person needs to crack open the egg, and one person needs to mix everything up.

- b. So one of these guys has to crack open the egg, right? *Ask the girl who she wants.*
  - c. And one of them has to pour in the milk, right? *Ask the girl who she wants.*
  - d. And one of them has to mix everything up. *Ask the girl who she wants.*
  - e. They are going to have a very small birthday party. The girl wants to invite some people to the party. *Ask her who.*
8. In this story, two sisters are helping their mom to wash the dog. There are 3 different jobs, and the mom has a good idea about who would be the best person to do each job. One person needs scrub the dog, one person needs to dry the dog off, and one person needs to brush the dog.
- a. So one of these guys has to scrub the dog, right? *Ask the girl who she wants.*
  - b. And one of them has to dry the dog off, right? *Ask the girl who she wants.*
  - c. And one of them has to brush the dog. *Ask the girl who she wants.*