



Wanna contraction in first language acquisition, child second language acquisition, and adult second language acquisition

Haerim Hwang

The Chinese University of Hong Kong

Research Article

Cite this article: Hwang, H. (2024). *Wanna contraction in first language acquisition, child second language acquisition, and adult second language acquisition*. *Bilingualism: Language and Cognition*, **27**, 322–333. <https://doi.org/10.1017/S1366728923000640>

Received: 10 November 2022
Revised: 16 August 2023
Accepted: 20 August 2023
First published online: 11 September 2023

Keywords:
wanna contraction; first language acquisition; child second language acquisition; adult second language acquisition; fundamental identity

Corresponding author:
Haerim Hwang;
Email: haerimhwang@cuhk.edu.hk

Abstract

Contraction of *want to* to *wanna* is sometimes possible (e.g., *Who do you want to/wanna stay with ___?*), but sometimes impossible (e.g., *Who do you want ___ to/*wanna stay?*). This contrast is attributable to the grammatical constraint that a *wh*-trace blocks the contraction of *want* and *to*. Most first language (L1) and second language (L2) acquisition studies testing learner knowledge of this constraint have used elicited production tasks and focused on adult participants, with inconsistent results. Using a child-friendly acceptability judgment task, the current study shows that children as young as 3;11 and both child and adult L2 learners have target-like knowledge of the constraint on *wanna* contraction. This result is in line with the position that L1 acquisition, child L2 acquisition, and adult L2 acquisition are qualitatively similar.

1. Introduction

The English phenomenon of our interest is *wanna*, a contracted form of *want to*. What makes this phenomenon interesting is that *wanna* contraction is sometimes possible, as in (1), but not always, as in (2) (Lakoff, 1970).

- (1) a. Who do you [want to, wanna] kiss ___?
b. Who do you [want to, wanna] dive with ___?
(Zukowski & Larsen, 2011, p. 213, (1a)–(1b))
- (2) a. Who do you [want ___ to, *wanna] kiss you?
b. Who do you [want ___ to, *wanna] dive first?
(Zukowski & Larsen, 2011, p. 213, (2))

This contrast can be considered in terms of subject *wh*-questions versus non-subject *wh*-questions. Whereas contraction between *want* and *to* is impossible if the question is about the subject of the *to*-infinitival clause (e.g., (2)), such contraction is possible if the question is about any other constituent within the *to*-infinitival clause, such as a direct object of the verb (e.g., (1a)) or the preposition (e.g., (1b)).

The contrast at issue has been explained by several theoretical accounts, including the *wh*-trace account (Chomsky, 1977; Chomsky & Lasnik, 1977; Lightfoot, 1976), the subject-sharing account (Postal & Pullum, 1982), the clitic climbing account (Goodall, 1991), and the emergentist account (O’Grady et al., 2008).¹ (For a constructivist approach, see Boas, 2004.²) The most widely accepted of these is the *wh*-trace account, which attributes the *wanna* contrast to the blocking effect of *wh*-movement. Specifically, the sentences in (2) involve extraction of the ‘subject’ of the *to*-infinitival complement from the position intervening between *want* and *to* to the front; this extraction leaves the trace of the subject (indicated by ___) in the original position, thus blocking the contraction of *want* and *to* over the trace. By contrast, the sentences in (1) involve extraction of non-subject constituents within the *to*-infinitival clause from positions other than between *want* and *to* to the front; hence, these cases do not give rise to a blocking effect. As such, there is a structurally-based constraint on *wanna* contraction.

Knowledge of the constraint on *wanna* contraction has been demonstrated in adult native language (L1) speakers of English, most clearly in comprehension. While production experiments using elicited production tasks or oral repair tasks have shown overgeneralized use of *wanna* contraction even over an intervening *wh*-trace (Kweon & Bley-Vroman, 2011; Zukowski & Larsen, 2011; see also Pullum, 1997), comprehension experiments using grammaticality judgment tasks have shown that adult native speakers accept possible *wanna*

© The Author(s), 2023. Published by Cambridge University Press. This is an Open Access article, distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike licence (<http://creativecommons.org/licenses/by-nc-sa/4.0>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the same Creative Commons licence is used to distribute the re-used or adapted article and the original article is properly cited. The written permission of Cambridge University Press must be obtained prior to any commercial use.



This article has earned badges for transparent research practices: Open Data and Open Materials. For details see the Data Availability Statement.

sentences (e.g., (1)) and reject impossible *wanna* sentences (e.g., (2)) (Ito, 2018; Kweon & Bley-Vroman, 2011).

When it comes to acquisition, however, the constraint on *wanna* contraction raises learnability challenges for both English-speaking children and second language (L2) learners of English. First, traces are not phonetically realized and so they are not observable in the input that learners are exposed to. Furthermore, it is unlikely that learners would be able to learn the target contrast (and particularly the ungrammaticality of subject questions involving *wanna* contraction) from input alone because subject questions have been found to be nearly absent in input. In the analysis of 700,000 adult utterances from the CHILDES database (MacWhinney, 2000), Zukowski and Larsen (2011) found 842 non-subject questions, including 576 questions using *want to* and 266 using *wanna*. However, they found only 12 subject questions, of which three were illicit (e.g., *What do you wanna go in our car?*). More crucially, learners do not receive negative evidence that would help them disallow illicit *wanna* contraction for subject questions. The same learnability issue also holds for L2ers of English (a) whose L1 does not have a *wanna* phenomenon, such as Japanese or Korean, and (b) who do not receive explicit instruction on *wanna* contraction in L2 classrooms.

In sum, the grammatical constraint on *wanna* contraction involves a learnability issue. Although a number of empirical studies on *wanna* contraction have attempted to investigate whether knowledge of the constraint might exist among both L1-English children (e.g., Crain & Thornton, 1998; Getz, 2019; Thornton, 1990; Zukowski & Larsen, 2011) and L2ers of English (e.g., Ito, 2018; Kweon, 2000; Kweon & Bley-Vroman, 2011; Witzel & Witzel, 2008), their findings have been inconsistent, making further work necessary.

Furthermore, previous acquisition studies have had some methodological issues. For example, the majority of them rely on elicited production tasks (cf. Ito, 2018; Kweon, 2000; Kweon & Bley-Vroman, 2011), which impose more cognitive burden on learners than comprehension tasks (Ionin & Zyzik, 2014) and are not as sensitive to the nuances of grammar as acceptability judgment tasks (Kweon & Bley-Vroman, 2011). The sentences tested in these studies are also rather complex, involving *do*-insertion as well as *wh*-movement. To address these issues, this study employs an acceptability judgment task created to be child-friendly and less cognitively demanding. The stimulus sentences are presented both aurally and in written form, and each is repeated twice in the task (e.g., Deen et al., 2018). To minimize the processing burden on the participants, both the words and structures of the stimulus sentences are as simple as possible (e.g., Friedmann et al., 2009). The four conditions and example items are shown in (3)–(6): (5) and (6) serve as baseline conditions.

- | | |
|----------------------------------------------------|------------------------------------------|
| (3) Who + Gap
(object question, $k = 5$): | <i>I wonder who you wanna work with.</i> |
| (4) *Who + No gap
(subject question, $k = 5$): | <i>*I wonder who you wanna work.</i> |
| (5) *If + Gap ($k = 5$): | <i>*I wonder if you wanna work with.</i> |
| (6) If + No gap ($k = 5$): | <i>I wonder if you wanna work.</i> |

Another important issue in previous L2 research on *wanna* contraction is that it has focused solely on adult L2ers. To expand the current body of research, this study tests both child and adult

L2ers of English. What makes looking at both groups particularly interesting is that these two groups show differences in cognitive resources and age of acquisition. For example, children are known to have fewer working memory resources than adults (Kharitonova et al., 2015; Swanson et al., 2006). Because sentences containing *wanna* contraction are syntactically complex, they may impose too much processing burden on L2ers, and especially on child L2ers. A possible result is that whereas adult L2ers will show target-like knowledge of the constraint on *wanna* contraction, the child L2ers will fail to show such knowledge. Alternatively, the critical period hypothesis (Abrahamsson & Hyltenstam, 2009; Lenneberg, 1967) suggests that successful acquisition of L2 morphology is no longer possible after the age of about 7 years (e.g., Johnson & Newport, 1989), which would give child L2ers an advantage over adult L2ers in acquiring *wanna* contraction, with the opposite results. Therefore, testing child L2ers of English and adult L2ers of English as well as L1-English children will provide us with a deeper understanding of how these groups compare with respect to the acquisition of a structurally-based constraint.

2. L1 acquisition research on *wanna* contraction

The first work on *wanna* contraction in L1 acquisition is Thornton's (1990) study (also reported in Crain & Thornton, 1998). In an elicited production task, he led 14 young children (age: 3;6–5;5) to produce *wh*-questions for a puppet who, the children were told, was too shy to talk to adults. The task had two conditions manipulated by prompts. The non-subject question condition asked about the direct object, the object of a preposition, or the second object in a double object construction in the *to*-infinitive complement of *want*, as in (7).

- (7) The rat looks kind of hungry. I bet he wants to eat something.
Ask him what.

(Crain & Thornton, 1998, p. 181)

The subject question condition asked about the subject of the *to*-infinitive complement of *want*, as in (8).

- (8) 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 & Thornton, 1998, p. 182)

The results showed that children as young as 3;6 had target-like knowledge of the constraint on *wanna* contraction. Whereas they used (licit) *wanna* contraction in 60 out of 68 non-subject questions (88%), they used (illicit) *wanna* contraction in only 6 out of 74 subject questions (8%). These results indicate the presence of knowledge of possible versus impossible *wanna* contraction in young children.

However, Zukowski and Larsen (2011) pointed out that Thornton's (1990) prompts include a confound. Unlike the non-subject question prompts (e.g., *Ask him what he wants to eat* — in (7)), the subject question prompts (e.g., *Ask the rat who he wants — to eat a cookie* in (8)) have the ellipsis in the position of the *wh*-trace, where a blocking effect arises. According to

Zukowski and Larsen, the study's use of such prompts may have led to the extremely low rates of *wanna* contraction in the children's subject questions. To address this confound, they modified Thornton's method in their Experiment 1 by using the full forms of embedded questions for both non-subject questions (e.g., *Ask him what he wants to eat*) and subject questions (e.g., *Ask the rat who he wants to eat a cookie*). (In Experiment 2, they indeed found an effect of the form of questions, which this paper will not discuss due to space limitations.) In addition, they varied critical questions by having two types of *wh*-phrase (*what*, *who*), which resulted in four conditions with five items each. The two groups of (a) children ($n = 13$; age 4;00 to 7;03) and (b) adult controls ($n = 14$) completed the modified elicited-production task.

Zukowski and Larsen (2011) did not find a significant effect of *wh*-phrase in either group. Their individual analysis showed that 12 adults (86%) made one or fewer *wanna* violations out of 10 and only one adult (7%) made four or more violations. By contrast, only two children (15%) produced one or fewer violations and seven (54%) made four or more *wanna* violations out of 10. This result was taken by the researchers to cast doubt on the claim that young children do have categorical knowledge of possible versus impossible *wanna* contraction.

However, Zukowski and Larsen's (2011) statistical analysis did not reveal any group-related interaction effect (i.e., group \times question type, group \times *wh*-phrase, group \times *wh*-phrase \times question type), which makes it hard to claim a significant difference between children and adults in how they treated possible and impossible *wanna* contraction. In addition, the two groups exhibited somewhat similar patterns in that they both used *wanna* contraction far less often in (illicit) subject questions than in (licit) non-subject questions.

Another study modeled on Thornton's (1990) was conducted by Getz (2019), who carried out two production experiments that varied by the lexical frequency of the embedded verbs (Experiment 1: low-frequency, medium-frequency; Experiment 2: high-frequency). Both experiments included younger children (Experiment 1: $n = 12$; age 3;09–4;10; Experiment 2: $n = 10$; age 3;09–4;09) and older children (Experiment 1: $n = 14$; age 5;03–7;03; Experiment 2: $n = 14$; age 5;00–7;03). Getz hypothesized that if the *wanna* constraint is purely structural, children should not produce the impossible *wanna* contraction whether the frequency of the embedded verbs is high (e.g., *do*) or low (e.g., *explore*). Overall, the results showed that the children's use of *wanna* was not adult-like regardless of their age. Furthermore, their accuracy differed depending on the frequency of the embedded verbs only in the context of the impossible *wanna* contraction: their use of the impossible *wanna* contraction decreased with higher-frequency embedded verbs.

Based on these results, Getz (2019) argued that a learning procedure for *wanna* contraction is necessary because "children apparently do not have access to [the structural constraint on it]" (p. 136). (To preview, our results, however, show target-like knowledge of *wanna* contraction in young children.) She proposed that children may learn the contrast in *wanna* contraction by storing instances of (a) *wanna* + embedded verb and (b) *want* + embedded verb as separate item-based constructions and keeping track of the different distributions of (a) and (b), which would lead to the adult-like generalization at a later stage of language acquisition. Although her study offers novel perspectives on the acquisition of *wanna* contraction, it raises a few concerns. First, lexical frequency was treated as categorical (high, medium, low) rather than continuous. Second, the embedded verbs were

not identical across the critical conditions. For example, whereas the low-frequency verbs for the possible condition were *carry*, *meet*, *share*, *surprise*, *paint*, and *visit*, those for the impossible condition were *cover*, *explore*, *fly*, *grow*, *hide*, and *kick*. To address this issue, we used the same embedded verbs across the conditions.

More crucially, it remains unclear why Getz (2019) observed a frequency effect only for the impossible *wanna* contraction. If children's learning mechanisms rely on the storage of particular item-based patterns and thus their frequency, then one would also expect this frequency effect to arise for the possible *wanna* contraction. Getz argued that "[h]igher-frequency verbs will be more likely to be encountered (hence represented) in a particular construction, so these verbs will be correctly acquired earlier" (p. 136); if so, it is conceivable that at least younger children, who are still in the process of generalizing the item-based patterns, would show a frequency effect in the possible *wanna* contraction, as well.

To summarize, whereas Thornton's (1990) child data suggest intact knowledge of the grammaticality contrast in *wanna* contraction in children as young as 3;6, Getz's (2019) data suggest the lack of such knowledge in children. Zukowski and Larsen's (2011) data are not clear enough to draw a firm conclusion. This discrepancy in previous literature highlights the need for further research.

3. L2 acquisition research on *wanna* contraction

Whether L2ers come to know the constraint on *wanna* contraction is controversial. Some studies report that they do so, or seem to do so (Ito, 2018; Witzel & Witzel, 2008), while other studies demonstrate that they do not (Kweon, 2000; Kweon & Bley-Vroman, 2011).

One of the most influential L2 studies on *wanna* contraction is Kweon and Bley-Vroman (2011; see also Kweon, 2000). They administered three tasks to 39 native speakers of English and 104 L1-Korean L2ers of English, whose proficiency the authors deemed 'advanced' based on e.g., their TOEFL scores of 550 or higher. However, it may not be fair to group all 104 L2ers as advanced, given that, for example, the average TOEFL score at the 50th percentile is between 550 and 589. The first task was an elicited production task based on Thornton's (1990) study, which was designed to elicit six subject questions as well as six object questions. Note that it is in the subject questions that *wanna* contraction is impossible. The second task was an oral repair task where participants heard five subject questions (e.g., **Who do you wanna help you with your homework?*) and five object questions (e.g., *What kind of book do you wanna buy in the book store?*); after hearing each question, they were asked to repeat it while rephrasing anything that sounded unnatural. The last task was a grammaticality judgment task in which participants rated 10 subject questions (e.g., **Who do you think the boys wanna go to the beach?*) and 10 object questions (e.g., *What do you think they wanna see in Hawai'i?*) on a four-point Likert scale (0: absolutely impossible; 1: probably impossible; 2: probably possible; 3: absolutely possible).

For data analysis, Kweon and Bley-Vroman (2011) proposed four categories to classify participants, as shown in Appendix S1 in Supplementary Materials. Participants who did not use/accept *wanna* in both subject and object questions were classified into the CONSERVATIVE group; those who used/accepted *wanna* only in object questions were classified into the

CORRECTLY DIFFERENTIAL group; those who used/accepted *wanna* only in subject questions were classified into the BACKWARD group; and those who used/accepted *wanna* in both subject and object questions were classified into the OVERGENERAL group. In order for *wanna* contraction to be considered part of the L2 grammar for each of the subject and object questions, a cut-off point was set at (a) more than one instance of *wanna* for the elicited production task and the oral repair task and (b) an average score of 2 for the grammaticality judgment task. Critically, Kweon and Bley-Vroman considered the difference between CORRECTLY DIFFERENTIAL and BACKWARD as a key indicator of the grammaticality contrast between subject and object questions with *wanna* contraction. In particular, those sensitive to this distinction can never fall into the category of BACKWARD.

The results showed obvious differences between native speakers of English and L1-Korean L2ers of English across the three tasks (see Appendix S2 in Supplementary Materials). In all three tasks, the majority of the native English speakers fell into the CORRECTLY DIFFERENTIAL category although many of them were also classified as CONSERVATIVE and OVERGENERAL in the elicited production task and the oral repair task. However, none of the native English speakers were BACKWARD. In the case of the L2ers, there is some suggestive evidence that learners' grammars do distinguish the subject and object questions: for all tasks, a greater number of L2ers are in the CORRECTLY DIFFERENTIAL category than in the BACKWARD category. This difference, however, approached statistical significance only in the oral repair data and acceptability judgment data, but not in the elicited production data. Furthermore, at least some L2ers ($n = 2-14$) fell into the BACKWARD category in every task.

One thing to note about Kweon and Bley-Vroman's (2011) categorization scheme, which has been established as a paradigm for examining individual grammar in follow-up L2 studies, is that the categories CONSERVATIVE and OVERGENERAL do not address the availability of the constraint on *wanna* contraction in learner grammar (p. 210). In fact, there seem to be many native English speakers who are liberal in the use of *wanna* in their production, overgeneralizing it to any question type (see also Pullum, 1997). Also problematic is what constitutes a valid cut-off criterion to classify contractors and non-contractors. Furthermore, the categorization scheme cannot take response bias into account. This study addresses all these issues by proposing a sensitivity score for *wanna* contraction (see Section 4.4); this score offers its own advantages as it is a continuous measure that effectively addresses response bias and provides a clearer understanding, compared to other sensitivity measures like d' scores (Wickens, 2002), of what extent individuals differentiate possible from impossible *wanna* contraction.

On the other hand, there is some evidence for knowledge of *wanna* contraction in L2 English. For example, Witzel and Witzel (2008) administered an elicited production task to 54 L1-Japanese L2ers of English whose proficiency was said to be intermediate by their instructor; this task aimed to elicit subject questions ($k = 6$) and object questions ($k = 6$). In their statistical analysis, Witzel and Witzel first excluded 19 participants who did not produce at least three *wh*-questions containing either *want to* or *wanna*; the average rate of *wanna wh*-questions from the remaining 35 L2ers was significantly higher in object questions (49%) than in subject questions (39%). For their individual analysis, they adjusted the cutoff value from more than one

instance of *wanna* (Kweon & Bley-Vroman, 2011) to the use of *wanna* in at least 33.3% of the produced subject or object questions. This choice was made because the more-than-one criterion was considered too conservative for their participants, as not all of them produced six subject questions and six object questions. Their analysis showed 16 CONSERVATIVE L2ers (45.71%), 4 CORRECTLY DIFFERENTIAL L2ers (11.42%), and 15 OVERGENERAL L2ers (42.85%). Importantly, not a single L2er showed the BACKWARD pattern.

Despite some differences between the two L2 studies discussed above, their results from production tasks are consistent in that many of the L2ers are CONSERVATIVE or OVERGENERAL. Crucially, the same pattern was observed even in the native English speakers (e.g., Kweon & Bley-Vroman, 2011). This fact casts doubt on the method of tapping into grammar using only production data, which has many limitations. Ionin and Zyzik (2014) pointed out that (a) the absence of a particular expression or (b) a production error does not necessarily indicate a lack of knowledge. It can be, in fact, attributed to other sources, such as "avoidance, phonological complexity, or difficulty with retrieval from memory" (p. 37). This study, therefore, employs an acceptability judgment task with the aim of examining how *wanna* contraction is represented in learner grammars.

Using an acceptability judgment task, Ito (2018) claimed that L1-Japanese L2ers' development pattern constitutes evidence for successful acquisition of the constraint on *wanna* contraction. The task was a paper-and-pencil offline task with four items for each of the six conditions. The critical condition was the subject question with contraction (e.g., **Who do you wanna advise Mary at the training session next week?*), which was the only ungrammatical condition among the six conditions. Also included were the subject question without contraction (e.g., *Who do you want to advise Mary at the training session next week?*), the object question with contraction (e.g., *Who do you wanna advise at the training session next week?*), and the object question without contraction (e.g., *Who do you want to advise at the training session next week?*). There were also two control conditions: the question without extraction but with contraction and the question without extraction and without contraction (e.g., *Do you {wanna/want to} advise Mary at the training session next week?*). Based on a Cloze proficiency test (Brown, 1980), 103 L2ers were divided into three proficiency groups: high, intermediate, and low. Results showed that with increasing proficiency, there was an increase of correct differentiations between the licit and illicit contraction patterns and a decrease of overgeneralized *wanna* patterns. This suggests the development of knowledge of *wanna* contraction in L1-Japanese L2ers of English.

Expanding on previous research, the current study attempts a novel method of conducting an acceptability judgment task to minimize the cognitive burden on participants in multiple ways (see Section 4.2).

4. The present study

The following research questions frame this study:

- RQ1: How early do native English-speaking children have knowledge of *wanna* contraction?
- RQ2: Do child L1-Korean L2ers have knowledge of *wanna* contraction? What role does L2 proficiency play?
- RQ3: Do adult L1-Korean L2ers have knowledge of *wanna* contraction? What role does L2 proficiency play?

With a novel way of conducting an acceptability judgment task, we predict that (some) participants in all three learner groups will show evidence of knowledge of *wanna* contraction. Although we do not have a specific prediction for RQ1, one possibility is that native English-speaking children will show target-like knowledge of the target phenomenon before or at the age of four, when children have been found to master most of their L1 grammar (e.g., Guasti, 2002). For RQ2 and RQ3, a proficiency effect is predicted such that higher-proficiency child and adult L2ers will show target-like knowledge of *wanna* contraction.

4.1 Participants

Seventy native-English-speaking adult controls ('L1 adults') and 46 native-English-speaking children ('L1 children') were recruited in Honolulu, Hawai'i. Forty-three L1-Korean child L2ers of English ('child L2ers') and thirty-one L1-Korean adult L2ers of English ('adult L2ers') were recruited in Seoul, Korea. This study received administrative and ethical clearance and obtained the informed consent from each participant (or from one of the parents in the case of child participants) prior to its beginning.

The two L2 groups differ in the age of their first exposure to English. The child L2ers were first exposed to English between ages 4 and 6, and the adult L2ers were first exposed to English between ages 8 and 12 (e.g., Kim & Schwartz, 2022). Note that the age of 7 was chosen as the cutoff age between the two L2 groups following Johnson and Newport (1989), who showed that children who begin L2 acquisition earlier than age 8 demonstrate target-like knowledge of various morphosyntactic phenomena. It is thus conceivable that the participants who started learning English above and below this age will show a qualitative difference in their grammar.

Among these participants, the data from seven L1 children and four child L2ers who exhibited an acceptance bias (Crain & Thornton, 1998) were excluded from the analyses. We applied a criterion of being able to reject at least one out of six ungrammatical control items (e.g., **Andrew played soccer because Paul baseball*; see Thornton et al., 2016). Also excluded were the data from two child L2ers whose proficiency level was impossible to gauge because they did not produce any sentence-level utterances in the picture narration proficiency task (Park, 2014; Unsworth, 2005; Whong-Barr & Schwartz, 2002; see Appendix S3 in Supplementary Materials). This procedure left us with data from 39 L1 children (two 3-year-olds, two 4-year-olds, nine

5-year-olds, 17 6-year-olds, and nine 7-year-olds) and 37 child L2ers, as well as 70 L1 adults and 31 adult L2ers.

The background information of the four participant groups is summarized in Table 1.

4.2 Acceptability judgment task

The stimuli for the acceptability judgment task (AJT) were 20 critical sentences and 48 filler sentences. The 20 critical sentences were crossed in a 2×2 Latin square design with the factors *Clause* (Who; If) and *Gap* (Gap; No gap), as shown in (3)–(6). Ten of these sentences were grammatical and another 10 were ungrammatical. The two If conditions served as the baseline in contrast to the two Who conditions with respect to grammaticality: the *If + Gap condition contrasts to the Who + Gap condition, and the If + No gap condition contrasts to the *Who + No gap condition. Appendix S4 in Supplementary Materials provides a full list of all critical items.

All critical and filler sentences were created so as to minimize the processing burden on participants. First, they were short in length (6 to 8 words). Second, for the critical items, *wanna* appeared in a simple indirect question that did not involve the operation of *do*-support because our L2ers' L1 (Korean) lacks this operation. Third, we ensured that the lexical items in the critical sentences were frequent and easy. The lemmas of all these items were among the 3,000 basic words of the English curriculum in Korea (Ministry of Education, 2020). We also confirmed that each lemma was frequent in the Corpus of Contemporary American English (Davies, 2008–): the mean rank of the lemmas of the lexical items was 716.86 ($SD = 843.86$; range = 6–3163). In addition, all arguments in the critical sentences were pronouns (i.e., *I*, *you*).

The embedded verbs following *wanna* were clearly intransitive ($k = 16$; e.g., *work*) or optionally (in)transitive verbs that, when transitive, do not typically allow a human object ($k = 4$; e.g., *read*, *walk*, *eat*, *drink*).³ Importantly, the use of these verbs in the illicit sentence type in (4) was intended to force participants to interpret this sentence type as a *wh*-question about the subject and not the object of the embedded verb (e.g., *work* in *I wonder who you wanna work*). If learners do overgeneralize *wanna* contraction everywhere as argued in previous studies (e.g., Kweon & Bley-Vroman, 2011; Zukowski & Larsen, 2011), they should accept *I wonder who you wanna work* because for them, it is essentially the same as *I wonder who you want ___ to work*.

Table 1. Background information of participants.

	Age at testing	Age of English onset	Length of residence in an English-speaking country in months
L1 Adults ($n = 70$)	23.27 ($SD = 5.19$; range = 18–49)	N/A	N/A
L1 Children ($n = 39$)	5.74 ($SD = 1.04$; range = 3–7)	N/A	N/A
Child L2ers ($n = 37$)	8.46 ($SD = 1.69$; range = 5–12)	5.00 ($SD = 0.78$; range = 4–6)	0.78 ($SD = 2.75$; range = 0–12)
Adult L2ers ($n = 31$)	22.94 ($SD = 2.92$; range = 18–30)	8.87 ($SD = 1.09$; range = 8–12)	2.94 ($SD = 5.78$; range = 0–24)

Each item was presented to participants as both an audio stimulus and a written sentence, the latter of which was expected to help L2ers whose main exposure to English might have been through written materials. For the ungrammatical sentences, the audio stimuli were created using cross-splicing techniques in Praat (Boersma & Weenink, 2017). To construct the audio stimulus for (4), for example, the first part of (3) (i.e., *I wonder who*) and the last part of (6) (i.e., *you wanna work*) were cut at the nearest zero-crossing points and then combined. Native English speakers confirmed that the sentences created in this manner sounded natural in terms of prosody.

4.3 Procedure

First, all adult participants or their parents in the case of child participants filled out a language background questionnaire on Google Form (see Appendix S5 in Supplementary Materials). All participants then completed our main task, the AJT, which was designed and presented in PsychoPy (Peirce, 2017). Next, they performed a picture-sentence matching task, which will not be discussed in this paper, and then the picture narration task. All participants were tested individually in a quiet room. The entire session took approximately 40–60 minutes (5 minutes for the questionnaire; 15–20 minutes for the AJT; 15 minutes for the picture-sentence matching task; 5–10 minutes for the picture narration task) including the break.

In the AJT, participants received instructions (see Appendix S4 in Supplementary Materials) and performed the task with four practice sentences. They then proceeded to the experimental session with two blocks. A break of approximately 5–10 minutes was given between the two blocks to prevent participants from losing interest. In each block, participants were presented with 10 critical sentences and 24 fillers in a pseudo-random order. Two stimuli from the same condition were never presented consecutively. For each item in the AJT, participants heard an audio stimulus twice with a one-second interval in between; at the same time, they were presented with the corresponding written sentence on the computer screen. At the offset of the audio stimulus, they were asked to judge each sentence on a 4-point ‘smiley face’ scale (see Figure 1) that popped up on the screen. The four smiley faces were described as ‘very bad/definitely impossible,’ ‘bad/impossible,’ ‘good/possible,’ and ‘very good/definitely possible’; an additional ‘I don’t know’ option was provided in the form of a question mark in case participants could not give a rating for any reason. Participants provided their judgments by pressing one of the images, which were attached to buttons on the keyboard. For analysis, their judgments as well as their reaction times (RTs) were recorded in PsychoPy. The RT data will not be reported in this paper.

As an independent measure of English proficiency, the picture narration task was administered to all L2 participants but only a subset of L1-English participants (32 L1 adults and 37 L1 children). In this task, the pictures were presented on PowerPoint and the stories the participants produced were recorded on Praat. Detailed information of the analysis of the

picture narration data for proficiency is provided in Appendix S3 in Supplementary Materials. Notably, there happened to be a significant group difference, with the adult L2ers showing higher proficiency scores than the child L2ers ($t(66) = 3.710$, $p < .001$, Cohen’s $d = 0.903$).

4.4 Data analysis

Before the main analysis, we removed the ‘I don’t know’ judgments (0.14% of the L1 adult data; 6.15% of the L1 child data; 5.27% of the L2 child data; 0.16% of the L2 adult data). We then converted all sentence ratings to binary format by coding the two smiling face responses as 1 (accept) and the two frowning face responses as 0 (reject).

Using the whole dataset, we first ran a binary logistic regression analysis (with a generalized linear mixed-effects model) on the judgment values (1; 0), with *Clause* (If; Who), *Gap* (Gap; No gap), and *Group* (L1 adults; L1 children; child L2ers; adult L2ers) as categorical fixed effects and participant and item as random effects. The fixed effects were contrast-coded for *Clause* (If: $-.5$; Who: $.5$) and *Gap* (Gap: $-.5$; No gap: $.5$) and simple-coded for *Group* with ‘L1 adults’ as a reference level. To further explore any group-related effects and carefully examine a group-specific performance on the AJT, we constructed a separate model for each group. For the L1 adult group, we ran a binary logistic mixed-effects model on the judgments, which included *Clause* and *Gap* as fixed effects and participant and item as random effects. To this model, we added *Age* as a continuous fixed effect for the L1 child data to investigate a potential effect of *Age*. *Age* was computed as the difference in months between the participant’s date of birth and date of testing. Separately for the child L2 data and the adult L2 data, we added the continuous fixed effect of *Proficiency* to the model. All these logistic mixed-effects models were constructed in R (R Core Team, 2022) with the maximal random effects structure justified by the design, using the ‘glmer’ function within the ‘lme4’ package (Bates et al., 2015). All models with the maximal random effects structure including all by-participant and by-item random slopes for all fixed effects converged, except the model based on the whole dataset. For this exceptional model, we progressively simplified the random effects structure until the model reached convergence (Barr et al., 2013); the final model had the by-participant random slopes for *Clause* and *Gap* and the by-item random slope for *Group* (model formula: $\text{Judgment} \sim \text{Clause} * \text{Gap} * \text{Group} + (1 + \text{Clause} * \text{Gap} | \text{Participant}) + (1 + \text{Group} | \text{Item})$).

Any significant interaction effects between *Clause* and *Gap* and between *Clause* and *Group* in a model were unpacked by post-hoc pairwise comparisons using the ‘emmeans’ package (Lenth, 2018) in R. Any three-way significant interactions among *Clause*, *Gap*, and *Age* or *Proficiency* were further examined by running a simple regression with *Age* or *Proficiency* as a predictor and ‘sensitivity scores on *wanna* contraction’ as a dependent variable. The sensitivity scores were computed by subtracting the acceptance rates of the ungrammatical conditions (*Who + No gap, *If + Gap) from the acceptance rates of the grammatical conditions (Who + Gap, If + No gap) such that higher scores could indicate higher sensitivity to *wanna* contraction. The use of this measure in analysis allowed us to test the relationship between (a) sensitivity to *wanna* contraction and (b) age (for the child data) or proficiency (for the L2 data).

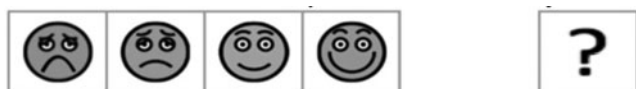


Figure 1. Four-point ‘smiley face’ scale.

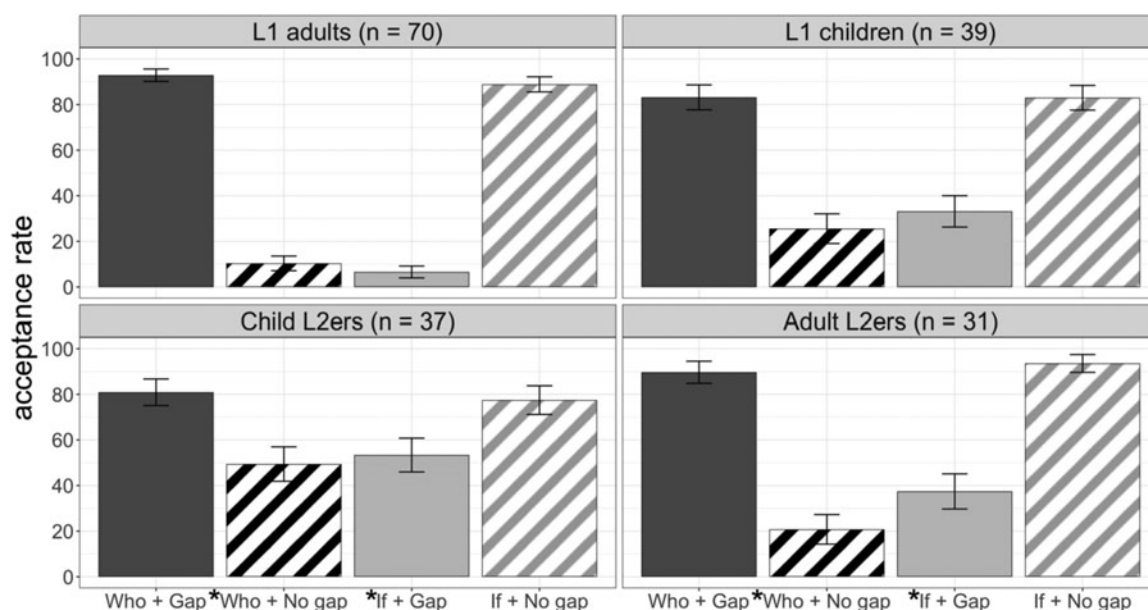


Figure 2. Mean acceptance rates (in %) per Condition and Group. Who + Gap: *wanna* contraction in the *who*-clause with a gap; *Who + No gap: *wanna* contraction in the *who*-clause without a gap; *If + Gap: *wanna* contraction in the *if*-clause with a gap; If + No gap: *wanna* contraction in the *if*-clause without a gap. Error bars represent 95% confidence intervals.

5. Results

A visual inspection of the graphed results (Figure 2) shows that the L1 adult controls accepted the grammatical conditions (Who + Gap, If + No gap) and rejected the ungrammatical conditions (*Who + No gap, *If + Gap). Although the acceptance patterns of the L1 children, child L2ers, and adult L2ers were similar to those of the L1 adults, the three learner groups accepted the two ungrammatical conditions more often than the L1 adults.

A mixed-effects regression analysis constructed on the whole dataset did not show a significant effect of *Clause* ($\beta = 0.251$, $SE = 0.214$, $p = .242$) or *Gap* ($\beta = -0.193$, $SE = 0.213$, $p = .363$). There was a significant *Group* effect between the child L2ers and L1 adults ($\beta = 1.117$, $SE = 0.377$, $p = .003$) and between the adult L2ers and L1 adults ($\beta = 1.144$, $SE = 0.436$, $p = .009$), but not between the L1 children and L1 adults ($\beta = 0.557$, $SE = 0.370$, $p = .132$). Importantly, the analysis showed a significant interaction between *Clause* and *Gap* ($\beta = -9.336$, $SE = 0.573$, $p < .001$). Post-hoc analyses to unpack the interaction revealed that the participants accepted the Who + Gap condition more often than the *Who + No gap condition ($\beta = 5.184$, $SE = 0.405$, $p < .001$) and *If + Gap condition ($\beta = -5.518$, $SE = 0.472$, $p < .001$). They also accepted the If + No gap condition more often than the *Who + No gap condition ($\beta = 4.646$, $SE = 0.346$, $p < .001$) and *If + Gap condition ($\beta = -4.979$, $SE = 0.424$, $p < .001$). Such a clear distinction between the grammatical sentences and the ungrammatical sentences in our participants as a group points to their knowledge of the constraint on *wanna* contraction.

On the other hand, there was no interaction between *Gap* and *Group* in any of the three learner groups ([L1 Children vs. L1 adults]: $\beta = -0.472$, $SE = 0.432$, $p = .275$; [child L2ers vs. L1 adults]: $\beta = -0.752$, $SE = 0.444$, $p = .090$; [adult L2ers vs. L1 adults]: $\beta = -0.584$, $SE = 0.471$, $p = .216$). However, an interaction between *Clause* and *Group* reached significance in all learner groups ([L1 Children vs. L1 adults]: $\beta = -1.511$, $SE = 0.436$, $p < .001$; [child

L2ers vs. L1 adults]: $\beta = -1.268$, $SE = 0.450$, $p = .005$; [adult L2ers vs. L1 adults]: $\beta = -1.932$, $SE = 0.481$, $p < .001$). Post-hoc analyses showed that the child L2ers ($\beta = -0.815$, $SE = 0.199$, $p = .001$) and the adult L2ers ($\beta = -0.784$, $SE = 0.207$, $p = 0.004$) accepted If conditions more often than the L1 adults did; and the child L2ers accepted Who conditions more often than the L1 adults did ($\beta = -0.620$, $SE = 0.172$, $p = .007$). The L1 children showed no particular pattern. Also, there emerged a significant three-way interaction among *Clause*, *Gap*, and *Group* ([L1 children vs. L1 adults]: $\beta = 7.561$, $SE = 1.259$, $p < .001$; [child L2ers vs. L1 adults]: $\beta = 11.343$, $SE = 1.278$, $p < .001$; [adult L2ers vs. L1 adults]: $\beta = 5.169$, $SE = 1.390$, $p < .001$).

To carefully examine these group-related effects, we conducted a separate analysis on the judgment data for each group, whose results are reported in the following sub-sections.

5.1 L1 adults

The mixed-effects regression model for the L1 adults did not show a significant effect of *Clause* ($\beta = 2.099$, $SE = 1.166$, $p = .072$) or *Gap* ($\beta = 0.259$, $SE = 1.177$, $p = .826$). However, it found a significant interaction between *Clause* and *Gap* ($\beta = -19.331$, $SE = 2.143$, $p < .001$). Post-hoc analyses revealed that this interaction stemmed from the fact that the L1 adults accepted the Who + Gap condition more often than the *Who + No gap condition ($\beta = 9.406$, $SE = 1.735$, $p < .001$) and *If + Gap condition ($\beta = -11.765$, $SE = 1.962$, $p < .001$); and that they accepted the If + No gap condition more often than the *Who + No gap condition ($\beta = 7.566$, $SE = 1.079$, $p < .001$) and If + Gap condition ($\beta = -9.925$, $SE = 1.434$, $p < .001$). This result indicates that L1 adults have firm knowledge of the constraint on *wanna* contraction.

5.2 L1 children

The mixed-effects regression model for the L1 children did not display a significant effect of *Clause* ($\beta = -0.481$, $SE = 1.428$,

$p = .736$), *Gap* ($\beta = 0.822$, $SE = 1.617$, $p = .611$), or *Age* ($\beta = 0.011$, $SE = 0.300$, $p = .971$). Nor was there any significant interaction effect between *Clause* and *Age* ($\beta = 0.087$, $SE = 0.281$, $p = .757$) or between *Gap* and *Age* ($\beta = -0.204$, $SE = 0.283$, $p = .470$). The model, however, showed a significant interaction effect of *Clause* and *Gap* ($\beta = 12.683$, $SE = 4.578$, $p = .006$) and a significant three-way interaction effect of *Clause*, *Gap*, and *Age* ($\beta = -3.370$, $SE = 0.767$, $p < .001$).

Our post-hoc analyses to unpack the two-way interaction showed that, as in the case of L1 adults, this effect arose from (a) a higher acceptance rate for the *Who* + *Gap* condition than for the **Who* + *No gap* condition ($\beta = 4.818$, $SE = 0.969$, $p < .001$) and **If* + *Gap* condition ($\beta = -4.361$, $SE = 0.930$, $p < .001$); and (b) a higher acceptance rate for the *If* + *No gap* condition than for the **Who* + *No gap* condition ($\beta = 4.120$, $SE = 0.690$, $p < .001$) and **If* + *Gap* condition ($\beta = -3.663$, $SE = 0.691$, $p < .001$). This result indicates that like L1 adults, L1 children have knowledge of the constraint on *wanna* contraction.

Crucially, an age effect was revealed by a follow-up simple regression analysis run on the sensitivity scores on *wanna* contraction such that older children showed higher grammaticality sensitivity ($\beta = 18.714$, $SE = 4.486$, $p < .001$), as shown in Figure 3. For the sensitivity scores for all participants, see Appendix S6 in Supplementary Materials. In our individual analysis, all but three L1 children were found to have a positive sensitivity score, which indicates that they had the grammaticality contrast involved in *wanna* contraction in the right direction. This pattern was found as early as the age of 3;11.

5.3 Child L2ers

In the mixed-effects regression model for the child L2ers, there was no significant effect of *Clause* ($\beta = 0.080$, $SE = 0.308$, $p = .795$), *Gap* ($\beta = -0.318$, $SE = 0.290$, $p = .273$), or *Proficiency* ($\beta = -0.039$, $SE = 0.106$, $p = .712$). No significant interaction was found between *Clause* and *Proficiency* ($\beta = 0.092$, $SE = 0.114$, $p = .423$) or between *Gap* and *Proficiency* ($\beta = 0.009$, $SE = 0.103$, $p = .932$). However, the model displayed a significant two-way interaction between *Clause* and *Gap* ($\beta = -3.947$, $SE = 0.719$, $p < .001$) and a significant three-way interaction among *Clause*, *Gap*, and *Proficiency* ($\beta = -1.121$, $SE = 0.255$, $p < .001$).

Post-hoc analyses showed that the sources of the two-way interaction are the same as those found for the L1 adults and the L1 children. The child L2ers accepted the *Who* + *Gap* condition more often than the **Who* + *No gap* condition ($\beta = 2.235$, $SE = 0.497$, $p < .001$) and **If* + *Gap* condition ($\beta = -1.974$, $SE = 0.518$, $p < .001$). In addition, the *If* + *No gap* condition was accepted more often than the **Who* + *No gap* condition ($\beta = 1.906$, $SE = 0.507$, $p = .001$) and **If* + *Gap* condition ($\beta = -1.645$, $SE = 0.506$, $p = .006$). This result suggests the child L2ers' sensitivity to the constraint on *wanna* contraction.

A simple regression of the sensitivity scores on *wanna* contraction showed that the three-way interaction came from the learners' different judgment patterns depending on their proficiency. As shown in Figure 4 (see also Appendix S6 in Supplementary Materials), child L2ers with higher proficiency had higher sensitivity to the *wanna* grammaticality contrast ($\beta = 8.344$, $SE = 1.714$, $p < .001$).

5.4 Adult L2ers

The mixed-effects regression model for the adult L2 data did not show a significant effect of *Clause* ($\beta = 1.215$, $SE = 2.084$, $p = .560$), *Gap* ($\beta = -2.096$, $SE = 2.118$, $p = .322$) or *Proficiency* ($\beta = -0.172$, $SE = 0.195$, $p = .379$). Two-way interactions between *Clause* and *Proficiency* ($\beta = -0.509$, $SE = 0.341$, $p = .135$) and between *Gap* and *Proficiency* ($\beta = 0.336$, $SE = 0.354$, $p = .342$) and a three-way interaction among *Clause*, *Gap*, and *Proficiency* ($\beta = 0.301$, $SE = 0.807$, $p = .710$) were not significant, either. It was only an interaction between *Clause* and *Gap* ($\beta = -13.620$, $SE = 3.920$, $p < .001$) that reached significance in the model.

As with the L1 adults, the L1 children, and the child L2ers, post-hoc analyses revealed that the *Clause*-by-*Gap* interaction was attributable to (a) the adult L2ers' (marginally) higher acceptance of the *Who* + *Gap* condition than of the **Who* + *No gap* condition ($\beta = 8.051$, $SE = 2.821$, $p = .022$) and **If* + *Gap* condition ($\beta = -7.138$, $SE = 2.800$, $p = .053$) and (b) their higher acceptance of the *If* + *No gap* condition than of the **Who* + *No gap* condition ($\beta = 5.843$, $SE = 1.527$, $p < .001$) and **If* + *Gap* condition ($\beta = -4.930$, $SE = 1.545$, $p = .008$). This result demonstrates the adult L2ers' knowledge of *wanna* contraction.

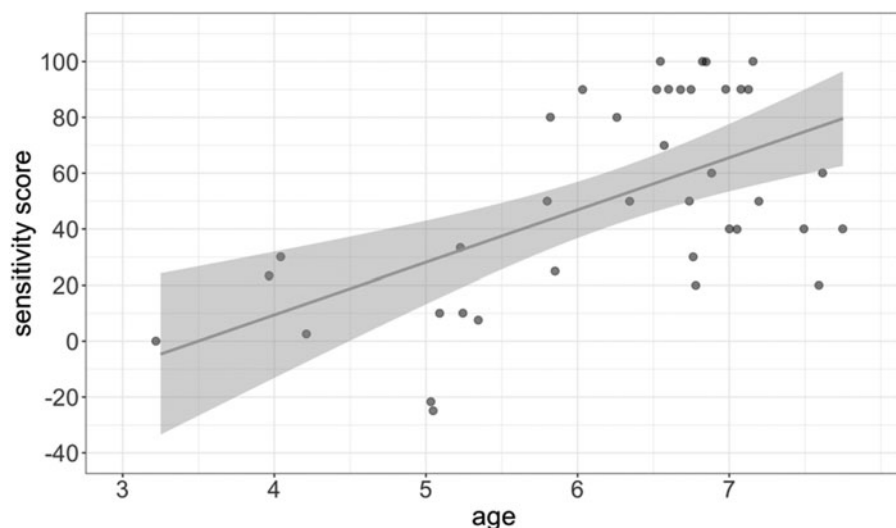


Figure 3. Relation between age and sensitivity score for the L1 children.

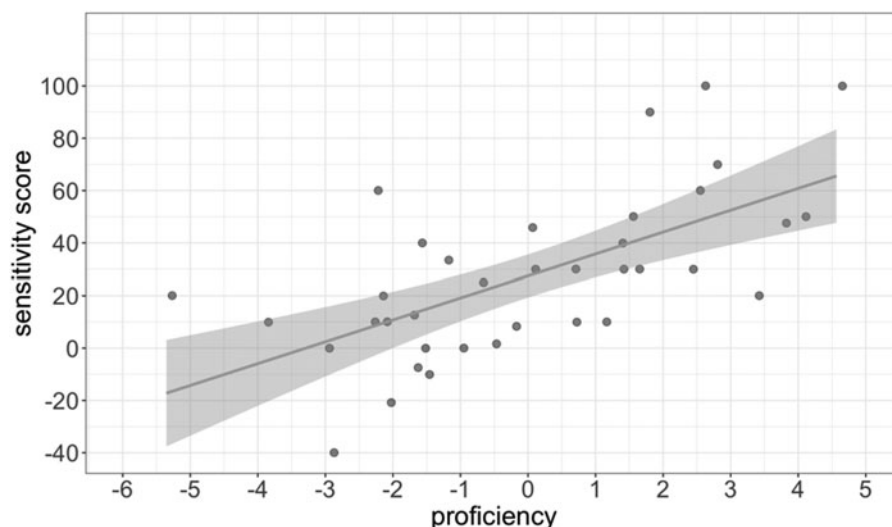


Figure 4. Relation between proficiency and sensitivity score for the child L2ers.

6. Discussion

The findings of this study indicate that English-speaking children, child L2ers of English (with higher proficiency), and adult L2ers of English manage to develop knowledge of the constraint on *wanna* contraction.

6.1 Fundamental identity in first language acquisition, child second language acquisition, and adult second language acquisition

Despite the fact that the grammaticality contrast involved in *wanna* contraction raises learnability challenges equally for English-speaking children, L1-Korean child L2ers of English, and L1-Korean adult L2ers of English, they successfully distinguished between possible *wanna* contraction and impossible *wanna* contraction in the acceptability judgment task. Note that our findings are inconsistent with the L1 findings from Getz (2019) and Zukowski and Larsen (2011) and the L2 findings from Kweon and Bley-Vroman (2011). One possible source of this discrepancy is the method. The previous studies adopted production tasks, which are vulnerable to performance errors and impose a large processing burden on learners (Ionin & Zyzik, 2014); Kweon and Bley-Vroman's study also used an acceptability judgment task, but some of their *wanna* sentences were formed as direct questions involving the complex operation of *do*-support. By contrast, the current study designed its acceptability judgment task to be child-friendly, with the *wanna* sentences made as simple as possible at both lexical and syntactic levels (see Section 4.2). Furthermore, each sentence was presented twice (e.g., Deen et al., 2018) to allow the learners to fully process the structural information in it (Ferreira & Patson, 2007). This novel design might have made it possible to unveil knowledge in children, child L2ers with higher proficiency, and adult L2ers where previous studies failed to do so (see also Kim & Schwartz, 2022).

Our findings also have further theoretical importance in that they suggest an answer to the controversial question of whether L1 acquisition and L2 acquisition are fundamentally different (e.g., Bley-Vroman, 1989, 1990, 2009) or the same (e.g., Hopp, 2007, 2009; Schwartz & Sprouse, 1996, 2013). The Fundamental Difference Hypothesis (FDH; Bley-Vroman, 1989, 1990) maintains that adult L2ers do not have access to a cognitive system specific to

language that is available in early childhood, as in L1 acquisition and child L2 acquisition; thus adult L2ers must resort to domain-general problem-solving skills and L1 grammar, which results in the failure of adult L2ers' grammars to converge on the target grammar.

According to Song and Schwartz (2009), the FDH is testable by (a) investigating whether adult L2ers have knowledge that is subject to learnability problems and (b) looking at how adult L2ers and child L2ers compare with respect to developmental sequences. The logic behind the latter is that similar developmental trajectories would indicate that the same mechanism specific to language guides the acquisition process both in child L2 acquisition and in adult L2 acquisition (Schwartz, 1987, 1992, 2004). In Song and Schwartz's study, L1-Korean-speaking children, L1-English child L2ers of Korean, and L1-English adult L2ers of Korean were tested for knowledge of *wh*-questions with the negative polarity item *amwuto* 'anyone' in Korean, which constitutes a learnability problem. Korean is a *wh*-in-situ language with subject-object-verb as its canonical word order, and it is generally possible to scramble the object to presubject position without a considerable meaning change beyond a shift of focus to the object. However, in the context of negative *wh*-object questions with the negative polarity item as subject, scrambling of the object *wh*-phrase is obligatory, as in (9a).

- (9) a. Scrambled word order (object-subject-verb)
 Mwues-ul amwuto sa-ci anh-ass-ni?
 what-ACC anyone buy-COMP NEG-PAST-Q
 'What didn't anyone buy?'
 b. Canonical word order (subject-object-verb)
 Amwuto mwues-ul sa-ci anh-ass-ni?
 anyone what-ACC buy-COMP NEG-PAST-Q
 'Didn't anyone buy something?'
 (adapted from Song & Schwartz, 2009, (3))

Crucially, the counterpart of (9a) with the canonical word order in (9b) cannot have a *wh*-question reading, but only a *yes-no* question reading. For L1-English L2ers of Korean, these properties of negative questions with the negative polarity item cannot be transferred from their L1, or learned from L2 instruction or target language input. Nevertheless, Song and Schwartz, using a variety of tasks (elicited production, acceptability judgment, and

interpretation verification), showed that (a) high-proficiency child and adult L2ers demonstrated firm knowledge of the target phenomenon and (b) child and adult L2ers follow the same developmental route to convergence on the target grammar. Their findings indicate that “the nature of language is fundamentally similar in natives and (child and adult) nonnatives” (p. 324), providing evidence against the FDH.

The findings of this study are consistent with those of Song and Schwartz (2009), thereby adding support to the fundamental identity position (Hopp, 2007, 2009). While the high proficiency of the adult L2ers in this study (see Section 4.1) means the findings do not provide information on their developmental sequence, all of the adult L2ers, as well as the higher-proficiency child L2ers, demonstrated firm knowledge of the constraint on *wanna* contraction, just like the L1 adults.

6.2 Child versus adult second language acquisition

Much research has documented child-adult differences in their L2 acquisition, and such differences are arguably due to age of acquisition and working memory capacity. An effect of age of onset was demonstrated in Johnson and Newport’s (1989) seminal study in which L2ers of English with different ages of acquisition (range: 3–39) were tested on a wide variety of structures of English grammar (for more recent work, see Bosch et al., 2019). The main finding from the study indicated an advantage for child L2ers over adult L2ers such that the performance of L2ers whose age of onset was greater than 7 never patterned like the performance of native speakers of English. Such deficits in knowledge among adult L2ers (see also Bley-Vroman, 1990; Clahsen & Muysken, 1986; Hawkins & Hattori, 2006; Tsimpli & Dimitrakopoulou, 2007) have been taken as evidence for the presence of a critical period in L2 acquisition (Abrahamsson & Hyltenstam, 2009; Lenneberg, 1967).

Regarding working memory, adults have greater capacity than children (Kharitonova et al., 2015; Swanson et al., 2006). Children’s ability to encode and maintain information indeed exhibits a remarkably protracted developmental improvement until adolescence. It is thus reasonable to consider that adults with greater working memory resources are more likely than children with fewer working memory resources to efficiently parse complex sentences, such as those containing a dependency between a *wh*-filler and a gap, as in the case of *wanna* contraction. Albeit controversial, a few studies have identified an adult advantage over children at least in the beginning stage of L2 acquisition (Hyltenstam & Abrahamsson, 2000; Long, 1990).

This study does not provide a conclusive answer as to the issues around age of onset or working memory because (a) it showed that both child L2ers and adults L2ers converged on the target-like knowledge and (b) it did not independently test working memory. However, we showed continuity between child and adult grammar in L2 acquisition, a result that would not be explained by either age of onset or working memory. All adult L2ers (who had higher proficiency than the child L2ers) did have tacit knowledge of the constraint on *wanna* contraction. The child L2ers as a group also showed target-like knowledge on *wanna* contraction. Further analyses revealed a proficiency effect in this group such that child L2ers’ sensitivity to the *wanna* contrast increased along with their proficiency. We leave the issue of child versus adult L2 acquisition open for future research with larger sample sizes of child and adult L2 participants whose age of onset and working memory are systematically varied but whose length of exposure to the target language and proficiency are controlled.

Acknowledgements. I would like to thank all participants in this study as well as Leilani Au, Jeffery Bock, Jihyun Kim, Rakhun Kim, Ju Young Min, Alison Onishi, and Yangon Rah, who helped me with data collection. I am also grateful for Robert Bley-Vroman, Kamil Deen, William O’Grady, Amy Schafer, and Bonnie D. Schwartz for their invaluable input to this work. This study was supported in part by a Fulbright Scholarship to the author.

Data availability statement. The data and materials that support the findings of this study are openly available in OSF at <http://doi.org/10.17605/OSF.IO/TR34D>.

Competing interests. The author declares none.

Supplementary Material. The supplementary material for this article can be found at <https://doi.org/10.1017/S1366728923000640>.

Appendix S1: Categorization Criteria for Participants in Kweon and Bley-Vroman (2011)

Appendix S2: Summary of Results in Kweon and Bley-Vroman (2011)

Appendix S3: Proficiency Data from L2 learners

Appendix S4: Critical Stimuli for the Acceptability Judgment Task

Appendix S5: Background Questionnaires

Appendix S6: Individual Sensitivity Scores in the Acceptability Judgment Task

Notes

1 O’Grady et al.’s (2008) emergentist approach maintains that a processor “operates in a linear manner, it combines elements, and it checks to make sure that lexical requirements (‘dependencies’) are being satisfied” (p. 479). Regarding the *wanna* pattern, they assume that *want* in (2) takes two nominal arguments and an infinitival argument (i.e., <N *want* N *to*>) and that two factors are involved in the processing of this pattern. One is the naturalness of contraction, according to which “contraction is most natural where the computational system is able to combine the involved elements immediately” (p. 481), such as *wanna* in rapid speech. The other is the processor’s propensity to resolve dependencies as early as possible. In (1) and (2), after the processor finishes combining *who* and *do*, *do* and *you*, and *you* (i.e., first argument of *want*) and *want*, it is given an opportunity for early resolution of the *wh*-dependency by associating *who* with the slot of the second argument of *want*, which delays the immediate combination of *want* and *to* (i.e., third argument of *want*). However, if naturalness of contraction to *wanna* has priority over early resolution of the *wh*-dependency, the processor will delay resolution at *want* and search for another opportunity at a later point in the sentence. If such an opportunity is encountered, the processor will accept the sentence, such as (1a) and (1b). Without such an opportunity, as in (2a) where the embedded verb has its second argument and (2b) where the embedded verb is intransitive, the processor will eventually reject these sentences.

2 Boas (2004) views the *wanna*-phenomenon as a construction “representing a form-meaning pair that links a specific form (phonological form: *wanna*, syntactic form: NP _ VP) with a specific meaning (= colloquial style)” (p. 484). On this view, whereas *wanna* in the *wanna* construction is a modal auxiliary verb which requires VP as a complement to denote the semantic value of *state of affairs*, *want* in the *want* construction requires a *to*-infinitival clause to do so. However, Boas does not provide an explicit explanation for the grammaticality distribution observed in (1) and (2).

3 An anonymous reviewer points out that *read* can take a human as its object (e.g., *I wonder who you wanna read*). The interrogative pronoun *who* in this sentence can be interpreted as referring to an author whose book one wants to read. We acknowledge that the use of this type of verb is a limitation of the study that needs to be addressed in future work.

References

Abrahamsson, N., & Hyltenstam, K. (2009). Age of onset and nativelikeness in a second language: Listener perception versus linguistic scrutiny. *Language Learning*, 59, 249–306. <https://doi.org/10.1111/j.1467-9922.2009.00507.x>

- Barr, D. J., Levy, R., Scheepers, C., & Tily, H. J. (2013). Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of Memory and Language*, 68, 255–278. <https://doi.org/10.1016/j.jml.2012.11.001>
- Bates, D., Maechler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, 67, 1–48. <https://doi.org/10.18637/jss.v067.i01>
- Bley-Vroman, R. W. (1989). What is the logical problem of foreign language learning? In S. M. Gass & J. Schachter (eds.), *Linguistic perspectives on second language acquisition* (pp. 41–68). Cambridge University Press. <https://doi.org/10.1017/CBO9781139524544.005>
- Bley-Vroman, R. W. (1990). The logical problem of foreign language learning. *Linguistic Analysis*, 20, 3–49.
- Bley-Vroman, R. W. (2009). The evolving context of the Fundamental Difference Hypothesis. *Studies in Second Language Acquisition*, 31, 175–198. <https://doi.org/10.1017/S0272263109090275>
- Boas, H. C. (2004). You wanna consider a constructional approach to wanna-contraction? In M. Achard & S. Kemmer (eds.), *Language, culture, and mind* (pp. 479–491). CSLI Publications.
- Boersma, P., & Weenink, D. (2017). Praat: Doing phonetics by computer (Version 6.0.36) [Software]. Available from <http://www.praat.org/>
- Bosch, S., Verissimo, J., & Clahsen, H. (2019). Inflectional morphology in bilingual language processing: An age-of-acquisition study. *Language Acquisition*, 26, 339–360. <https://doi.org/10.1080/10489223.2019.1570204>
- Brown, J. D. (1980). Relative merits of four methods for scoring cloze tests. *The Modern Language Journal*, 64, 311–317. <https://doi.org/10.1111/j.1540-4781.1980.tb05198.x>
- Chomsky, N. (1977). On wh-movement. In P. Culicover, T. Wasow & A. Akmajian (eds.), *Formal syntax* (pp. 71–132). Academic Press.
- Chomsky, N., & Lasnik, H. (1977). Filters and control. *Linguistic Inquiry*, 8, 425–504.
- Clahsen, H., & Muysken, P. (1986). The availability of universal grammar to adult and child learners: A study of the acquisition of German word order. *Interlanguage studies bulletin (Utrecht)*, 2, 93–119. <https://doi.org/10.1177/026765838600200201>
- Crain, S., & Thornton, R. (1998). *Investigating Universal Grammar*. MIT Press.
- Davies, M. (2008–). The corpus of contemporary American English: 450 million words, 1990–present. Available from <http://corpus.byu.edu/coca>
- Deen, K., Bondoc, I., Camp, A., Estioca, S., Hwang, H., Shin, G.-H., Takahashi, M., Zenker, F., & Zhong, J. (2018). Repetition brings success: Revealing knowledge of the passive voice. In A. B. Bertolini & M. J. Kaplan (eds.), *Proceedings of the 42nd annual Boston University Conference on Language Development* (pp. 200–213). Cascadia Press.
- Ferreira, F., & Patson, N. D. (2007). The “good enough” approach to language comprehension. *Language and Linguistic Compass*, 1, 71–83. <https://doi.org/10.1111/j.1749-818X.2007.00007.x>
- Friedmann, N., Belletti, A., & Rizzi, L. (2009). Relativized relatives: Types of intervention in the acquisition of A-bar dependencies. *Lingua*, 119, 67–88. <https://doi.org/10.1016/j.lingua.2008.09.002>
- Getz, H. R. (2019). Acquiring wanna: Beyond universal grammar. *Language Acquisition*, 26, 119–143. <https://doi.org/10.1080/10489223.2018.1470242>
- Goodall, G. (1991). Wanna-contraction as restructuring. In C. Georgopoulos & R. Ishihara (eds.), *Interdisciplinary approaches to language* (pp. 239–254). Kluwer. https://doi.org/10.1007/978-94-011-3818-5_12
- Guasti, M. T. (2002). *Language acquisition: The growth of grammar*. MIT Press.
- Hawkins, R., & Hattori, H. (2006). Interpretation of English multiple wh-questions by Japanese speakers: A missing uninterpretable feature account. *Second Language Research*, 22, 269–301. <https://doi.org/10.1191/0267658306sr269oa>
- Hopp, H. (2007). *Ultimate attainment at the interfaces in second language acquisition: Grammar and processing* (Unpublished doctoral dissertation). University of Groningen, Groningen, Netherlands.
- Hopp, H. (2009). The syntax–discourse interface in near-native L2 acquisition: Off-line and on-line performance. *Bilingualism: Language and Cognition*, 12, 463–483. <https://doi.org/10.1017/S1366728909990253>
- Hyltenstam, K., & Abrahamsson, N. (2000). Who can become native-like in a second language? All, some, or none? On the maturational constraints controversy in second language acquisition. *Studia Linguistica*, 54, 150–166.
- Inonin, T., & Zyzik, E. (2014). Judgment and interpretation tasks in second language research. *Annual Review of Applied Linguistics*, 34, 37–64. <https://doi.org/10.1017/S0267190514000026>
- Ito, Y. (2018). Acquisition of contraction constraint by Japanese learners of English. *Journal of Pan-Pacific Association of Applied Linguistics*, 22, 19–41.
- Johnson, J., & Newport, E. (1989). Critical period effects in second language learning: The influence of maturational state on the acquisition of English as a second language. *Cognitive Psychology*, 21, 60–99. [https://doi.org/10.1016/0010-0285\(89\)90003-0](https://doi.org/10.1016/0010-0285(89)90003-0)
- Kharitonova, M., Winter, W., & Sheridan, M. A. (2015). As working memory grows: A developmental account of neural bases of working memory capacity in 5- to 8-year old children and adults. *Journal of Cognitive Neuroscience*, 27, 1775–1788.
- Kim, K., & Schwartz, B. D. (2022). Learnability in the acquisition of the English tough construction by L1-Korean adult and child L2 learners. *Second Language Research*, 38, 259–287.
- Kweon, S.-O. (2000). *The acquisition of English contraction phenomena by advanced Korean learners of English: Experimental studies on wanna contraction and auxiliary contraction* (Unpublished PhD dissertation). University of Hawai'i, Honolulu, HI.
- Kweon, S.-O., & Bley-Vroman, R. (2011). Acquisition of the constraints on wanna contraction by advanced second language learners: Universal grammar and imperfect knowledge. *Second Language Research*, 27, 207–228.
- Lakoff, G. (1970). Global rules. *Language*, 46, 627–639. <https://doi.org/10.2307/412310>
- Lenneberg, E. (1967). *Language in the context of growth and maturation*. John Wiley & Sons.
- Lenth, R. (2018). emmeans: Estimated marginal means, aka least-squares means. R package version 1.2.2. Retrieved from <https://CRAN.R-project.org/package=emmeans>
- Lightfoot, D. (1976). Trace theory and twice-moved NPs. *Linguistic Inquiry*, 7, 559–582.
- Long, M. (1990). Maturational constraints on language development. *Studies in Second Language Acquisition*, 12, 251–285. <https://doi.org/10.1017/S0272263100009165>
- MacWhinney, B. (2000). *The CHILDES project: Tools for analyzing talk* (3rd ed.). Lawrence Erlbaum Associates.
- Ministry of Education. (2020). *The English national curriculum*. Ministry of Education.
- O'Grady, W., Nakamura, M., & Ito, Y. (2008). Want-to contraction in second language acquisition: An emergentist approach. *Lingua*, 118, 478–498. <https://doi.org/10.1016/j.lingua.2007.01.006>
- Park, K.-S. (2014). *Information structure and dative word-order alternations in English and Korean: L1 children, L2 children, and L2 adults* (Unpublished doctoral dissertation). University of Hawai'i, Honolulu, HI.
- Peirce, J. (2017). PsychoPy (Version 1.85.3) [Software]. Available from <http://www.psychopy.org/>
- Postal, P. M., & Pullum, G. K. (1982). The contraction debate. *Linguistic Inquiry*, 13, 122–138.
- Pullum, G. K. (1997). The morpholexical nature of English to-contraction. *Language*, 73, 79–102. <https://doi.org/10.2307/416594>
- R Core Team. (2022). R: A language and environment for statistical computing. R foundation for statistical computing, Vienna, Austria [Software]. Available from <https://www.R-project.org/>
- Schwartz, B. D. (1987). *The modular basis of second language acquisition* (Unpublished PhD dissertation). University of Southern California, Los Angeles, CA.
- Schwartz, B. D. (1992). Testing between UG-based and problem-solving models of L2A: Developmental sequence data. *Language Acquisition*, 2, 1–19.
- Schwartz, B. D. (2004). Why child L2 acquisition? In J. van Kampen & S. Baauw (eds.), *Proceedings of GALA 2003* (Vol. 1) (pp. 47–66). Netherlands Graduate School of Linguistics (LOT).
- Schwartz, B. D., & Sprouse, R. A. (1996). L2 cognitive states and the Full Transfer/Full Access model. *Second Language Research*, 12, 40–72. <https://doi.org/10.1177/026765839601200103>
- Schwartz, B. D., & Sprouse, R. A. (2013). Generative approaches and the poverty of the stimulus. In J. Herschensohn & M. Young-Scholten (eds.),

- Handbook of second language acquisition* (pp. 137–158). Cambridge University Press. <https://doi.org/10.1017/CBO9781139051729.010>
- Song, H. S., & Schwartz, B. D. (2009). Testing the fundamental difference hypothesis: L2 adult, L2 child, and L1 child comparisons in the acquisition of Korean *wh*-constructions with negative polarity items. *Studies in Second Language Acquisition*, 31, 323–361. <https://doi.org/10.1017/S0272263109090329>
- Swanson, H. L., Sáez, L., & Gerber, M. (2006). Growth in literacy and cognition in bilingual children at risk or not at risk for reading disabilities. *Journal of Educational Psychology*, 98, 247. <https://doi.org/10.1037/0022-0663.98.2.247>
- Thornton, R. J. (1990). *Adventures in long-distance moving: The acquisition of complex wh-questions* (Unpublished PhD dissertation). University of Connecticut, Storrs, CT.
- Thornton, R. J., Notley, A., Moscati, V., & Crain, S. (2016). Two negations for the price of one. *Glossa: A Journal of General Linguistics*, 1, 1–30. <http://dx.doi.org/10.5334/gjgl.4>
- Tsimpli, I.-M., & Dimitrakopoulou, M. (2007). The Interpretability Hypothesis: Evidence from *wh*-interrogatives in second language acquisition. *Second Language Research*, 23, 215–242. <https://doi.org/10.1177/0267658307076546>
- Unsworth, S. (2005). *Child L2, adult L2, child L1: Differences and similarities. A study on the acquisition of direct object scrambling in Dutch* (Unpublished PhD dissertation). Utrecht University, Utrecht, Netherlands.
- Whong-Barr, M., & Schwartz, B. D. (2002). Morphological and syntactic transfer in child L2 acquisition of the English dative alternation. *Studies in Second Language Acquisition*, 24, 579–616. <https://doi.org/10.1017/S0272263102004035>
- Wickens, T. D. (2002). *Elementary signal detection theory*. Oxford University Press.
- Witzel, J. D., & Witzel, N. O. (2008). *Wanna* contraction in intermediate-level Japanese learners of English. *Journal of Second Language Acquisition and Teaching*, 15, 121–138.
- Zukowski, A., & Larsen, J. (2011). *Wanna* contraction in children: Retesting and revising the developmental facts. *Language Acquisition*, 18, 211–241.