When the Learning Gets Tough: Children's Accent-Based Learning Choices are Influenced by Processing Difficulty

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Abstract

Children use a variety of cues to decide who they can trust to be a credible source of information. One such cue is accent. Previous research has attributed accent-based preferences to a bias for in-group members. In the present study, we examine another potential contributor to these preferences: processing difficulty. Four- to seven-year-old children completed a selective word-learning task, in which they were presented with pairs of speakers and needed to choose one to learn a new word from. The speakers differed in accent type – native or non-native – and non-native speakers differed in how difficult their speech was to process. Children were more likely to choose to learn from the speaker whose speech was easier to process, and the magnitude of this effect was linearly related to the processing difficulty disparity between the two speakers: the greater the disparity, the stronger the effect. These findings are the first to demonstrate the role of processing difficulty in children's accent-based selective learning.

Keywords: processing difficulty, intelligibility, accents, selective learning, accent bias

Introduction

Learning is an active process; we filter through mass amounts of information each day, committing the most important pieces to memory. In this age of misinformation, it is even more critical that we can sift through the noise to decide what is true and who we can trust. Although this is true for adults, it is arguably more critical for children, who are constantly encountering information for the first time. But studies have shown that children are selective learners, weighing multiple cues when deciding who they can trust to provide accurate information (see Sobel & Finiasz, 2020 for a review). For example, children have been shown to want to learn from individuals who have proven to be accurate or reliable in the past (Nurmsoo & Robinson, 2009; Birch, Vauthier, & Bloom, 2007; Brooker & Poulin-Dubois, 2013; Clement, Koenig, & Harris, 2004; Koenig, Clement, & Harris, 2004; Koenig & Harris, 2005), display certainty (Brosseau-Liard, Cassels & Birch, 2014), demonstrate knowledge (Einav & Robinson, 2011; Mangardich & Sabbagh, 2018), and are familiar (Corriveau & Harris, 2009).

Another cue that has been shown to play a role in children's selective learning is accent. Preschool children are more likely to endorse labels and functions for novel objects from people who speak in their native accent compared to those who have an unfamiliar accent (Corriveau, Kinzler & Harris, 2013; Kinzler, Corriveau & Harris, 2011; Kertesz, Alvarez, Afraymovich & Sullivan, 2021). These accent-based learning preferences may be rooted in children's strong social preferences for those who speak in their native accent: Four to six year olds are more likely to choose native-accented speakers as friends (DeJesus et al., 2017; Kinzler, Dupoux & Spelke, 2007; Kinzler et al., 2009; Paquette-Smith et al., 2019; Souza, Byers-Heinlein & Poulin-Dubois, 2013) and older children allocate more resources to their native accented counterparts (Spence & Imuta, 2020).

Why are children more likely to prefer native-accented speakers? The dominant account is that they reflect children's preferences for in-group members (Kinzler, 2021). Accent is a particularly strong cue to group membership (Cohen, 2012) and children have been shown to use accent to infer information about an individual's background. For example, North American children are likely to indicate that non-native accented individuals are from somewhere else (Weatherhead, Friedman & White, 2018; Hwang & Markson, 2018).

Given that children infer that speakers with different accents live in different places (Weatherhead, White, & Friedman, 2016), children might also make the inference that they have different knowledge. It is therefore possible that accent-based selective learning hinges on a more nuanced inference: who will have the most relevant information. Indeed, previous work has shown that infants expect those who speak their native language to have information that is more relevant to them than individuals who speak a foreign language (Begus, Gliga & Southgate, 2016). Although most work looking at accent-based learning preferences cannot disentangle whether these are due to group membership alone or a more nuanced inference about

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information relevance, children have been shown to choose to learn object labels from informants with non-native accents when they are told the objects are from "far away" (Rett & White, 2019). This suggests that the potential relevance of an individual's knowledge does influence children judgments – when they believe that a non-native speaker has more relevant information in a particular situation (because, like the toy, they are more likely to be from "far away"), their preference changes.

However, the usefulness of information depends on more than accuracy or relevance; information is only useful if it is accessible to the learner. For example, learners may dis-prefer a teacher who is accurate but presents information in an overly complicated manner, compared to a teacher who presents information clearly and concisely. This is supported by findings that children prefer teachers who provide non-circular explanations over circular explanations (Corriveau & Kurkul, 2014). The issue of accessibility leads us to examine another possible contributor to children's learning preferences: how difficult the information is to process, and further, understand.

Studies show that processing effort influences accuracy and credibility judgements. Adults judge statements that are repeated (Hassan & Barber, 2021) and statements that rhyme (McGlone & Tofighbakhsh, 2000) as more accurate, presumably because they are easier to process. And statements printed in font that is difficult to read are judged as less true (Reber & Schwarz, 1999). Additionally, when given the choice between spoken statements presented in low-noise or high-noise, 4- to 5-year-old children are more likely to endorse those with lower noise, and thus are easier to process (Bernard, Proust & Clement, 2014).

Meanwhile, it is well documented that unfamiliar accents introduce processing costs. Infants under 19 months struggle to recognize familiar words (Best et al., 2009; van Heugten & Johnson, 2014) and match them to their referents (Mulak et al., 2013; van Heugten, Krieger & Johnson, 2015; White & Aslin, 2011) when they are presented in unfamiliarly accented speech. At school age, children continue to struggle to identify words spoken by non-native accented speakers (Bent & Atagi, 2017; Nathan et al., 1998), and adults demonstrate slower processing speeds and decreased accuracy for unfamiliarly accented speech (reviewed in Cristia et al., 2012). Thus, processing challenges introduced through accent (a result of the mismatch between an individual's productions and a listener's linguistic system) are evident across the lifespan.

We propose that increased processing difficulty introduced by unfamiliarly accented speech influences accent-based selective learning biases, such that we are less likely to trust and learn from speakers with unfamiliar accents in part because the information that they provide is more difficult to process.

Few studies have directly investigated how the difficulty of processing an unfamiliar accented is related to information evaluation in adults. Adults rate statements as less true when they are presented by non-native accented speakers compared to native accented speakers (Lev-Ari & Keysar, 2010; but see Lorenzoni, Faccio & Navarrete, 2024). However, exposure to the non-native accent appears to decrease this effect, a change directly linked to increased intelligibility (Boduch-Grabka & Lev-Ari, 2021), and in the case of highly intelligible regional accents, no effect is observed (Frances, Costa & Baus, 2018). Similarly, Rovetti, Sumantry and Russo (2023) investigated the influence of accent exposure on speaker credibility. Credibility ratings increased following accent exposure, and this effect was mediated by intelligibility and listening effort.

Collectively, these studies suggest that adults' judgments of both the truthfulness of information and a speaker's trustworthiness are influenced by accent, with this effect closely tied to measures of processing difficulty.

No studies to date have investigated the role of processing difficulty on children's learning choices, either broadly or in the context of accent. The present study seeks to address this gap. We tested children aged 4 to 7 years old using a selective word learning paradigm. On each trial, children saw an image of a novel object and were asked to choose one of two speakers to provide its name. Speakers included native speakers of English and non-native speakers of English, the latter exhibiting speech that varied in processing difficulty. The experiment included two main trial types: *native*, whereby a native accented speaker was paired against a non-native accented speaker, and *non-native*, whereby non-native accented speakers were paired against each other. This design allowed us to explore the impact of processing difficulty on children's selective learning choices both within and outside of the native-speaker bias. We predicted that in both cases, children would prefer to learn from the speaker who generated less processing difficulty, with the strength of this effect depending on the degree of processing difficulty disparity between the two speakers.

Methods

Participants

4- to 7-year-old English-speaking children (N = 304, M_{age} = 5.32) participated through the Children Helping Science (www.childrenhelpingscience.com) online study recruitment platform. Children were recruited from the international participant pool and varied on their language background and region of residence, with the majority participating out of the United States. All sessions were video recorded through the Lookit/CHS platform.

Stimuli

Audio stimuli were recorded in English by 4 North American speakers, 2 native Italian speakers and 2 native Chinese speakers. A total of 12 neutral sentences (e.g., *Nighttime is when tired children go to sleep*) and 16 minimal word pairs (e.g., *lock-rock*) were recorded.

The processing difficulty of each native Chinese and native Italian speaker (henceforth referred to as "non-native accented speakers") was determined through an adult speech perception study. Adult monolingual English speakers (N = 86) were recruited from the University of Waterloo's undergraduate participant pool and asked to listen to a randomly presented series of statements read by 12 speakers (the 4 non-native accented speakers in addition to 8 native accented speakers, 4 of whom were used in the present study). Participants provided a comprehensibility rating for each statement on a scale of 1 to 100, with higher scores indicating higher comprehensibility. We use comprehensibility as a measure of processing difficulty (where processing difficulty is inversely related to comprehensibility).

Based on these ratings, four levels of processing difficulty were assigned to the non-native speakers: PD1, PD2, PD3, PD4 (where the most comprehensible speaker was assigned to PD1 and the least comprehensible speaker assigned to PD4). To understand how these levels differed, a one-way ANOVA was conducted on comprehensibility ratings, $F(3, 332) = 15.11$, $p < .001$. Post-hoc tests revealed that all comparisons were statistically significant (all ps < .05) except for PD1 vs. PD2 and PD2 vs. PD3. These data informed the study design and predictions.

Table 1. Comprehensibility ratings for non-native speakers by processing difficulty level.

Level	Average Comprehensibility Rating
PD1	71.35
PD2	67.12
PD3	62.95
PD4	50.79

Table 2. Trial types.

Trial Types	Processing Difficulty Comparison	Trial Variant
Native Trials	Native vs. Lower PD	Native vs. PD1
		Native vs. PD2
Native Trials	Native vs. Highter PD	Native vs. PD3
		Native vs. PD4
Non-native Trials	Lower PD vs. Higher PD	PD1 vs PD4
		PD1 vs PD3
		PD2 vs PD4
		PD2 vs PD3

General Procedure

Participants completed the study online through the Children Helping Science (CHS) platform (www.childrenhelpingscience.com). Parents were instructed to assist their children only when necessary (e.g., to address technical difficulties or click the mouse if their child was unable to themselves).

The study was programmed in a web-based experimental software called Gorilla (https://gorilla.sc/) and consisted of a training task, a selective learning task and a comprehension task. Prior to each task an audio recording played with instructions. Children were unable to advance until the instructions were complete, at which point a play button appeared on the screen that needed to be clicked to start the task. This automated, self-paced design ensured that children were provided with the instructions they needed and that they were engaged prior to beginning each task. Only the selective learning task will be reported here.

Selective Learning Task

In the selective learning task, children were told that they would be shown new toys and listen to two girls talk. Their job was to learn the names of the new toys by choosing which girl they wanted to learn from. Several automatic screen progressions with pre-recorded instructions guided children through the task. They were first shown a picture of the toy, then two silhouettes appeared on the left and right side of the screen. A box appeared around the left silhouette and children were asked to click on it, at which point one of the neutral sentences recorded by one of the speakers was played. The same procedure then occurred for the right silhouette. After listening to both speakers, children were asked to drag the toy to the speaker that they wanted to learn from. Once a response was made children were automatically progressed to the next trial. Responses were recorded by the Gorilla software.

Children completed 12 trials of the selective learning task, split into 4 blocks. Each block consisted of 3 types of trials: Native vs. Non-native lower processing difficulty, Native vs. Non-native higher processing difficulty, and Non-native lower vs. Non-native higher processing difficulty (see Table 2). Trial types were randomized within the block. The specific speakers, audio stimuli (i.e., sentence), speaker side (i.e., left or right), and block order were counterbalanced. Although we grouped non-native speakers into two levels of processing difficulty (lower and higher) for study design simplicity, we planned to analyse the four levels independently. This design allowed us to compare the effect of nativeness vs. non-nativeness (including all levels of processing difficulty: "Native Trials"), and the effect of processing difficulty without nativeness ("Non-native Trials").

If processing difficulty impacts children's selective word learning, then we predict two outcomes. First, we should see the native speaker bias increase in Native Trials as processing difficulty of the non-native accented speaker increases. For example, children should be more likely to select the native speaker for Native vs. PD4 trials compared to Native vs. PD1 or Native vs. PD2 trials. Second, in the case of Non-native Trials, we should see that children are more likely to choose to learn from the speaker who elicits lower processing difficulty, and we predict that this effect will be larger when the processing difficulty disparity is larger between speakers (e.g., in the case of a PD1 vs. PD4 trial).

Results

Data collection for this study is ongoing. Results presented are inclusive of data up until January 31, 2025 (n=304; target N = 370 as per power analysis).

Responses to the selective learning trials were coded based on processing difficulty. Selecting the speaker of lower processing difficulty resulted in a score of 1, while selecting the speaker of higher processing difficulty resulted in a score of 0. As such, for Native Trials, the native speaker was always scored as a 1 and the non-native speaker a 0.

Overall, children chose the lower processing difficulty speaker at significantly above chance levels, $t(304) = 12.54$, $M = 0.65$, $p < .001$. Recall that Native Trials can only tell us how children respond when nativeness is a factor, directly testing the native speaker bias as it relates to processing difficulty. Meanwhile, Non-native Trials control for nativeness, thus testing the processing difficulty effect independent of a native-speaker comparison. As such, further analyses were conducted on the two trial types separately. Each dataset was subjected to a Generalized Linear Mixed Model (GLMM) with speaker choice as the dependent measure compared across trial variants; this tells us how the magnitude of the native speaker bias or processing difficulty effect differs with different processing difficulty disparities. Linear contrasts were also conducted to directly test the linear effect of processing difficulty on speaker choices.

Native Speaker Trials

Overall, children chose the native English speaker at significantly above chance levels, $t(304) = 11.62$, $M = 0.66$, $p < .001$, demonstrating a native speaker bias. Since we were most interested in how the level of processing difficulty influenced children's choices, native speaker trials were next analysed as four distinct trial types: Native-PD1, Native-PD2, Native-PD3 and Native-PD4.

Table 3. Descriptive Statistics for Response Strength by Trial Type for Native Trials

Trial Type	Mean (M)	Standard Deviation (SD)
Native-PD1	0.63	0.48
Native-PD2	0.64	0.48
Native-PD3	0.65	0.48
Native-PD4	0.71	0.45

A generalized linear mixed-effects model with a binomial distribution was conducted to test the effects of trial type, age, and their interaction. There was a significant main effect of trial type, $\chi^2(3) = 12.18$, $p = .0068$, and a significant main effect of age, $\chi^2(3) = 37.06$, $p < .001$, but no interaction, $\chi^2(9) = 9.89$, $p = .359$.

Post-hoc pairwise comparisons revealed a significant difference for Native-PD1 vs. Native-PD4 trials, z = -3.70, $p = .0013$, and for Native-PD2 vs. Native-PD4 trials, z = -2.74, $p = .0317$. Additionally, the comparison between Native-PD3 and Native-PD4 trials showed a similar pattern, z = -2.37, $p = .0833$. All other comparisons were not significant. This is consistent with our predictions: children showed significantly greater native-speaker preferences when the native speakers were paired against PD4 (the least comprehensible non-native speaker) than when they were paired against PD1 or PD2 (the most comprehensible non-native speakers).

To more directly demonstrate that children were more likely to choose the native speaker as processing difficulty of the non-native speaker increased, a linear contrast was conducted with the four trial type levels in order of difficulty of the non-native speaker: PD1, PD2, PD3 and PD4. A significant linear effect was found ($p = 0.00163$).

Non-Native Speaker Trials

Overall, children chose the speaker who elicited lower processing difficulty at significantly above chance rates, $t(304) = 8.59$, $M = 0.62$, $p < .001$.

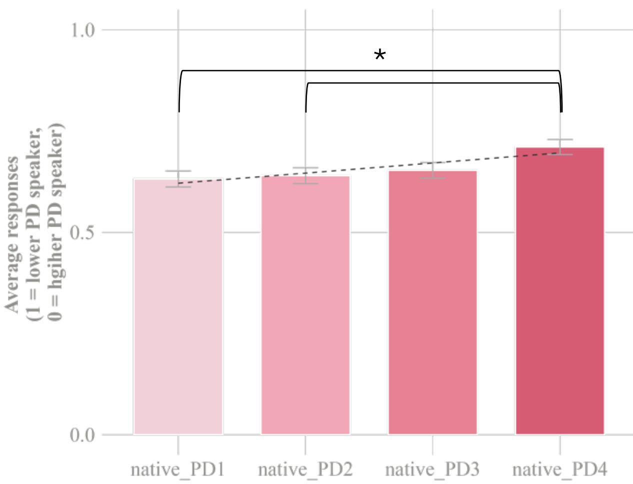

Figure 1. GLMM results for Native Trials, with linear trend line.

A generalized linear mixed-effects model with a binomial distribution was conducted to test the effects of trial type, age, and their interaction. There was a significant main effect of trial type, $\chi^2(3) = 10.58$, $p = .014$, and a significant main effect of age, $\chi^2(3) = 26.01$, $p < .001$, but no interaction, $\chi^2(9) = 9.04$, $p = .433$.

Post-hoc tests revealed a marginally significant difference between PD1-PD4 and PD2-PD3 trials, $z = 2.98$, $p = .0145$. All other comparisons were not significant. This demonstrates that children were more likely to choose the speaker who was easier to understand but only when there was a larger disparity (i.e., PD1-PD4).

Table 4. Descriptive Statistics for Response Strength by Trial Type for Non-native Trials

Trial Type	Mean (M)	Standard Deviation (SD)
PD2-PD3	0.58	0.50
PD1-PD3	0.59	0.49
PD2-PD4	0.64	0.48
PD1-PD4	0.69	0.46

To more directly demonstrate that children were more likely to choose the speaker whose speech was easier to process as the difference between the speakers increased, a linear contrast was conducted with the four trial variants entered accordingly (from smallest processing difference to greatest difference): PD2-PD3, PD1-PD3, PD2-PD4, PD1-PD4. A significant linear effect was found ($p = 0.00134$).

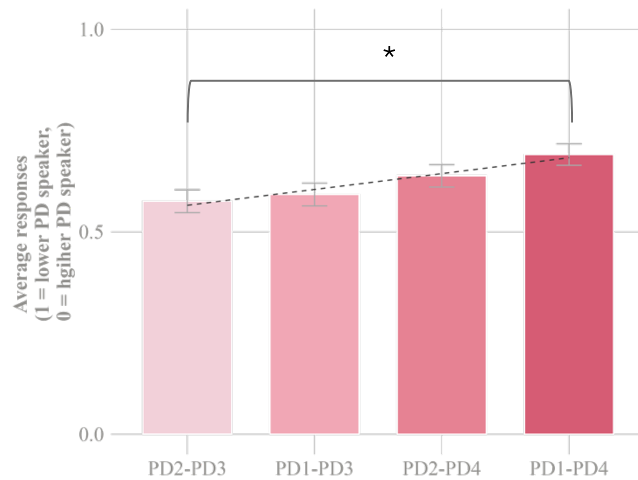

Figure 2. GLMM results for Non-native Trials with linear trend line.

Discussion

The current study is the first to demonstrate the role of processing difficulty in children's accent-based selective learning. Four- to seven-year-old children were more likely to choose to learn from the speaker who elicited lower processing difficulty, and the magnitude of this effect was linearly related to the processing difficulty disparity between the speaker pair: the greater the disparity, the stronger the preference.

In Native trial types, we replicated the native speaker bias established in previous work. However, children's native speaker bias was strongest when paired with the non-native speaker who elicited the highest level of processing difficulty, and weakest when paired with the speaker who elicited the lowest level of processing difficulty.

Non-native trial types allowed us to investigate the processing difficulty effect while controlling for nativeness. Again, the processing difficulty effect was strongest when children were asked to choose between the two speakers who elicited the lowest and highest levels of processing difficulty, and weakest when asked to choose between those who were not that different in processing difficulty.

Taken together, these findings suggest that the increased processing difficulty introduced by unfamiliar accents is related to children's selective learning choices. They are less inclined to trust and learn from people whose speech is harder to understand. Children's graded sensitivity to processing difficulty is consistent with several other pieces of evidence. For example, children generally show stronger social preferences when native speakers are pit against speakers with a foreign accent than when they are pit against speakers with a regional accent (e.g., Canadian children choosing between Korean- or British-accented speakers; Paquette-Smith et al., 2019). In addition, categorization work suggests that children are more sensitive to the difference between foreign accents and their own (than regional accents and their own; Girard et al., 2008). These findings have been attributed to the fact that foreign accents may differ along more dimensions than regional accents.

One possibility is that processing difficulty contributes directly to selective learning choices because reduced comprehensibility makes it difficult to extract relevant information. In this case, we might expect children's responses to be less related to processing difficulty in a different type of learning situation (e.g., a non-verbal learning task, such as learning an object function through imitation, rather than a word-learning task). A second possibility is that increased processing difficulty increases negative affect, and this relationship mediates the relationship between processing difficulty and negative judgements (Dragojevic & Giles, 2016). It is not a stretch to think that in the current study, processing difficulty may have influenced children's selective learning by first influencing their affective state. In this case, we would expect children to demonstrate a similar sensitivity to processing difficulty regardless of the task type.

An alternative explanation for our findings must be addressed. While we label our primary independent variable "processing difficulty", we recognize that it is difficult to separate processing difficulty from "accentedness". Accents that are more difficult for a listener to process are also those that are further from the native variant, and thus those that point more strongly to out-group membership. Previous research also shows that children use accent strength to determine how far away someone lives (Weatherhead, Friedman & White, 2019). But children show stronger social preferences for native speakers when the other individual speaks with another accent, compared to another language (Spence, Hornsey & Imuta, 2021). While accent and language should point to out-group membership similarly, only accent introduces processing costs (we cannot process languages that we do not know), suggesting that processing difficulty is involved. That said, follow-up studies that directly manipulate accent exposure are in progress to further disentangle "accentedness" from processing difficulty. It is known that children and adults can adapt to accents with exposure (Smith, Holmes-Elliot, Pettinato & Knight, 2014; Adank, Evans, Stuart-Smith & Scott, 2009; White & Aslin, 2011) reducing processing difficulty and increasing comprehensibility. If we see that adapting to an individual's accent increases the likeliness to want to learn from them, then this would show strong support for the processing difficulty hypothesis presented here.

One limitation of the current study design is that our measure of processing difficulty, introduced through accent, was based on adult ratings. To ensure children can comprehend all speakers to some degree and that the degree of comprehension varies with our adult ratings of accent strength, a follow-up study with children in the same age group will be conducted.

The present study is the first to demonstrate the role of processing difficulty in children's accent-based selective learning biases. Although alternative explanations exist and will be addressed in future work, it is important to note that they are not mutually exclusive to our own conclusions. Processing difficulty may influence children's selective learning choices through multiple pathways, opening new directions and implications for research in selective learning.

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