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Language for $200: success in the environment influences grammatical alignment

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Abstract

Speakers constantly learn language from the environment by sampling their linguistic input and adjusting their representations accordingly. Logically, people should attend more to the environment and adjust their behavior in accordance with it more the lower their success in the environment is. We test whether the learning of linguistic input follows this general principle in two studies: a corpus analysis of a TV game show, Jeopardy, and a laboratory task modeled after Go Fish. We show that lower (non-linguistic) success in the task modulates learning of and reliance on linguistic patterns in the environment. In Study 1, we find that poorer performance increases conformity with linguistic norms, as reflected by increased preference for frequent grammatical structures. In Study 2, which consists of a more interactive setting, poorer performance increases learning from the immediate social environment, as reflected by greater repetition of others' grammatical structures. We propose that these results have implications for models of language production and language learning and for the propagation of language change. In particular, they suggest that linguistic changes might spread more quickly in times of crisis, or when the gap between more and less successful people is larger. The results might also suggest that innovations stem from successful individuals while their propagation would depend on relatively less successful individuals. We provide a few historical examples that are in line with the first suggested implication, namely, that the spread of linguistic changes is accelerated during difficult times, such as war time and an economic downturn.

Key words: success; accommodation; language learning; structural alignment; linguistic variation; environmental fitness; structural accommodation; language change.

1. Introduction

People learn language from the environment. This learning occurs at all linguistic levels, from higher aspects of communication, such as pragmatics, down to low-level features, such as sound categories. This learning is not constrained to the initial stages of language acquisition but continues throughout individuals' lives. People constantly monitor the environment and adjust their representations accordingly. Logically, adjustment to the environment would be optimal if it is sensitive to the degree to which the learner is successful in it—the less successful an individual is, the more the individual should adjust to the environment. In this article, we test whether the learning of linguistic input follows this general principle and therefore depends on an individual's success in the environment.

We will first discuss research showing that people learn from the environment throughout their lives and distinguish between relying on information from the immediate versus past environment. We will next present research showing that both attention to the environment and learning are modulated by success in it. We will then present two studies that test whether (non-linguistic) success in the environment can similarly modulate attention to and reliance on linguistic patterns in the past and immediate environment. We will end with a discussion of the implications of our findings to the process of language evolution and change, and in particular, examine a few historical cases in which the spread of linguistic change accelerated during difficult times, namely, war time, and economic downturn.

1.1 Learning language from the environment

The linguistic representations we have are shaped by the input we receive. For example, infants construct the phonological categories of their language by sampling the distributions of sounds in the environment. Consequently, the number and shape of their categories are influenced by the distributional properties of the input they receive from their environment (e.g., Maye et al. 2002; Kuhl 2004). Importantly, these representations are not fixed but are in constant flux since learning continues throughout adulthood (e.g., Goldinger 1998; Bertelson et al. 2003; Norris et al. 2003; Vroomen et al. 2007; Kraljic et al. 2008; Samuel and Kraljic 2009; Foulkes and Hay 2015; Kleinschmidt and Jaeger 2015). Thus, exposure to a different dialect or language can change the phonetic categories used even in one's native language and dialect (e.g., Flege and Eefting 1987; Flege 1987, 1995; Major 1992; Sancier and Fowler 1997; Lev-Ari and Peperkamp 2013). The malleability of linguistic representations and their adjustment to the environmental input also allows individuals to participate in community-level linguistic changes. Some linguistic changes take place during a person's life-time, and individual speakers accordingly modify their language use with time, as has been shown, for example, by tracking the changes in the pronunciation of Queen Elizabeth II over the years (Harrington et al. 2000).

Learning from the environment occurs on two different axes, learning from life-long exposure and learning from the immediate environment. On the one hand, people rely on life-long accumulated knowledge about the distribution to guide their processing and production. This is one of the postulated reasons that linguistic changes are more advanced among younger than among older adults, as older adults' accumulated experience renders their representations more resistant to change [see Sankoff and Blondeau (2007) for a discussion of the role of age in language change]. At the same time, people also adapt to the immediate environment. This is most clearly reflected in communication alignment (often called accommodation), the process by which interlocutors converge toward each other's language. Alignment takes place at all aspects of the communication, from speech rate and pitch to use of dialectical variants, lexical entrainment, and non-verbal gestures (e.g., Coupland 1980; Street 1982; Gregory et al. 1993; Chartrand and Bargh 1999; Pickering and Garrod 2004; Reitter and Moore 2014; but see Healey et al. 2014). Importantly, it has been proposed that such alignment can have long-term effects on language use. For example, at the phonological level, the speech of students converges to the speech of their roommates with time (Pardo et al. 2012 but see Abrego-Collier et al. 2011), and dialect leveling has been suggested to occur as a result of speakers of different dialects aligning with one another (Trudgill 1986).

At the structural level, alignment has been found as well, in both interactive (Branigan et al. 2000; Gries 2005; Jaeger and Snider 2013) and non-interactive contexts [Bock 1986; see Pickering and Ferreira (2008) for an overview]. For example, participants who hear a picture described as *A rock star sold the undercover agent some cocaine* are more likely to describe a different picture using such double object structure than participants who hear the picture being described with the prepositional object structure *A rock star sold some cocaine to the undercover agent* (Bock 1986). At this structural level, alignment has often been interpreted as being primarily automatic rather than social (Branigan et al. 2010), although some recent evidence suggest it might be sensitive to social factors or contextual goals as well (Reitter and Moore 2014; Schoot et al. 2014; Weatherholtz et al. 2014; Lev-Ari, 2016). Even at the cognitive level, it has been argued that alignment might result from more than one underlying mechanism. Specifically, it has been proposed to occur as a result of both short-term priming and long-term implicit learning of the structure (Ferreira and Bock 2006).

There is mounting evidence, then, that shows that, at all linguistic levels, speakers constantly monitor and sample the linguistic input in the environment, and adjust their representations and use accordingly.

1.2 Success in the environment and learning

Although there is a vast literature that investigates how people learn from and adjust to their environment, we argue that the processes of learning from the

environment and deviation from learned norms are both modulated by an individual's success in the environment. Importantly, we argue that the level of success in the environment can influence linguistic behavior even when level of success is independent of linguistic performance. In the real world, success can be reflected in myriad ways, from social standing, through financial success to achievement of goals in any other domain. We hypothesize that success would influence performance, because, ideally, when individuals perform poorly in an environment, they should invest more resources to investigate it, learn its structure, and adjust their behavior accordingly.

In the linguistic domain, it has been suggested that learning is error-based (Chang et al. 2006; Jaeger and Snider 2013). That is, individuals adjust their linguistic representations when the incoming input differs from what would be predicted by their previous experience. As the adjustment is in response to the error, it is greater the bigger the error.

Research on mood suggests that success in the environment can have much more extensive influence. First, it suggests that success can influence not only a specific representation but also the manner in which information is attended to and processed. Second, it suggests that the influence can extend to behavior in domains which are unrelated to the domain in which an individual succeeded or failed. Specifically, research within the framework of mood-as-information proposes that people use their mood as an indicator of how well they are doing, and adjust their behavior accordingly. If they are in a bad mood, they implicitly infer from their mood that they should change their behavior because it is not optimal. They consequently increase their attention to the context in search of additional information and alternative strategies (e.g., Schwarz 1990; Bless and Fiedler 2006; Clore and Huntsinger 2007). In line with this theory, shoppers on rainy days were shown to remember better which items were displayed in a shop compared with shoppers on sunny days, presumably because the bad weather, which was shown to affect their mood, led to greater attention to the context (Forgas et al. 2009). Similarly, there is some evidence that bad mood improves implicit learning. Thus, participants who were exposed to sad pictures performed better on an artificial grammar task than participants who saw neutral or positive pictures (Pretz et al. 2010), and participants who saw a short clip of a sad movie were better at detecting co-variation in later input than those who watched a clip of a funny movie (Braverman 2005).

Mood can also influence reliance on input and conventions that have already been learned. Thus, while good mood increases reliance on scripts and heuristics (e.g., Bless and Fiedler 2006), it also decrease conformity with normative behavior. For example, people in a good mood make less polite requests (Forgas 1999).

Similarly, power, which is a proxy of success in the environment, influences what people attend to and what type of information they rely on. Thus, power influences the degree to which individuals adopt the perspective of others (Galinsky et al. 2006) or adjust their judgments about others' attitudes and traits away from their own attitudes and traits (Overbeck and Droutman 2013).

Both mood and power, then, have been shown to influence attention allocation, manner of processing, and the weight that is given to different types of information. These effects have been argued to be due to the link between mood or power and success. Because bad mood and low power reflect poor success in the environment, people adjust their behavior in order to improve their standing. Therefore, low success in the environment should have an even greater influence on performance, as it is the root cause of these effects. Crucially, mood influences behavior even when its source is unrelated to the measured behavior. That is, even though the source of the mood in the reviewed studies was sad films, pictures, or bad weather, it influenced behavior on tasks unrelated to those mood inducing stimuli. Therefore, in this article, we test whether non-linguistic success in the environment, operationalized as success in a game, influences reliance on linguistic norms (Study 1) and adjustment to linguistic patterns in the immediate environment (Studies 1 and 2).

Language learning has often been conceptualized as the sampling of the entire input with the only limitation being cognitive capacities. Some evidence, however, suggests that the degree to which individuals adjust their language to the environment is not constant across contexts. For example, an analysis of the speech of the TV host Larry King has indicated that he aligns his pitch more toward interviewers of higher rather than lower status (Gregory and Webster 1996). Relatedly, the spread of language change depends on social status. Thus, language change often depends on speakers' gender, socioeconomic status, and their intersection (e.g., Labov 1972, 1990; Cameron 2003). For example, speakers' position in society has been argued to negatively correlate with their openness to ongoing linguistic changes, as speakers of high status try to maintain the status quo also linguistically, whereas those in less favorable position are more likely to adopt contemporary variants from the immediate environment (Kroch 1978; Guy et al. 1986). The role of status in speech alignment during the interaction and in the process of language change suggests that the level of success in the

environment influences linguistic learning, as those of higher status could be seen as more successful. It might therefore be the case that less successful people would be more likely to adjust their behavior to the environment or would do so to a greater degree.

We test our hypothesis about the role that success in the environment plays in reliance on linguistic norms and linguistic patterns in the environment by examining adjustment of grammatical choice in a TV game show, Jeopardy, and then in a modified version of the game Go Fish in the laboratory. These are particularly strict tests of our hypothesis, as success in these contexts does not depend on linguistic performance. These cases, then, allow us to examine the generality of the sensitivity of the linguistic learning mechanisms to environmental success.

We test speakers' reliance on linguistic norms and on their immediate environment by examining the degree to which individuals' structural selection is influenced by structure frequency in general and by its frequency in the immediate environment, respectively. It is a well-established fact that speakers' structural choices are influenced by both the structure's general frequency and by the structural choice of previous speakers (Bock 1986). This study, however, is among the first to examine whether this influence is modulated by a non-linguistic factor other than conceptual similarity or frequency (Jaeger and Snider 2008; Pickering and Branigan 1998), namely, success in the environment. Specifically, it tests whether greater success in the environment leads to reduced reliance on linguistic norms and reduced adjustment to linguistic patterns in the environment.

2. Study 1

To examine whether success in the environment influences reliance on linguistic norms and adjustment to the linguistic patterns in the immediate environment, we coded transcripts from the trivia TV game-show Jeopardy. A game show provides a particularly favorable environment for examining the role of success, as performance level changes throughout the game, such that the same player might be winning at one point in the game, but be losing at another point. In the game of Jeopardy, three players see a response to a question (e.g., 'He's the giraffe mascot for Toys 'R Us', or 'They're the red in red flannel hash') and need to provide the question that corresponds to that response (e.g., 'Who is Geoffrey?' or 'What are beets?', respectively) as quickly as possible. The first player to do so receives the amount of money associated with that question. A wrong response leads to a deduction of this amount of money. The response clues are organized by category and monetary value. In each round of the game, there are six categories corresponding to six topics. In each category, there are five response clues whose associated value ranges from \$100 to \$500 in increments of \$100 in the first round, and from \$200 to \$1000 in increments of \$200 in the second round. In each turn, the player who last won gets to choose the clue to be presented by naming the category and amount of money. Importantly, there are two common ways to refer to the combination of category and amount of money: by using a preposition [category] for [\$] (e.g., *Natural Wonders for \$200*), or without a preposition [category] [\$] (e.g., *Natural Wonders \$200*). In general, the inclusion of a preposition is the more common way to state an intersection of two categories, as is also reflected in the structures' overall frequencies in the coded Jeopardy corpus (with preposition: 66%, without a preposition: 34%). We tested whether poorer performance, as reflected in lower amount won by that point in the game, increased the likelihood that players produce the frequent structure and the likelihood that they repeat the structure used by the previous speaker.

2.1 Method

2.1.1 *Corpus selection*. We selected three episodes from each year between 2002 and 2011, six episodes from 2012, and five episodes from 2013. The only constraint for selection was that no player appears in more than one episode (as the winner of an episode continues to the next one). The fourty-one selected episodes thus contained 123 unique speakers.

2.1.2 *Coding*. We examined all the utterances where both the category name and the amount of money were stated ($N = 2{,}280$). For each of these utterances, we coded whether or not a preposition preceded the stated amount of money. Then, we coded whether its structure was the same as the structure that the previous player had used. One hundred and fifteen utterances were produced by the first player before other players had a chance to play, or followed turns in which players did not produce both the category name and the amount of money. As they could not be coded for repetition, they were excluded from analysis, leaving 2,165 utterances. For each utterance, we also coded the amount of money that the speaker had gained up until that point in time in the game.

2.2 Results and discussion

We ran a logistic mixed-model analysis (Jaeger 2008) with Speaker and Episode as random variables, and Previous Speaker (used a preposition coded as 1, did not

use a preposition coded as 0), Amount Won along with its second degree polynomial, and the interaction of Amount Won and the quadratic term of Amount Won with Previous Speaker. Amount Won was centered prior to the analysis. The dependent measure was a binary coding of whether speakers used the less frequent structure. The model included intercepts but no slopes because the model would not converge if any of the slopes was added.[1] We included a polynomial in the model in order to test whether the level of success shows diminishing influence as it increases, since a visual examination of the data suggested that this might indeed be the case. The results showed that, as predicted, the more money speakers had won by the time of speaking, the less likely they were to use the frequent structure ($\widehat{\beta}$= 1.31e−04, SE = 3.41e−05, $Z = 3.83$, $P < 0.001$; see Fig. 1), but that success had a diminishing effect, such that additional increases in success led to smaller increases in this likelihood ($\widehat{\beta}$=−8.47e−09, SE = 3.49e−09, $Z = -2.43$, $P < 0.02$). The effect of adjustment to the immediate environment, as reflected by imitation of the structure used by the previous speaker, was not significant ($\widehat{\beta}$=−0.25, SE = 0.19, $Z = -1.31$, n.s.). There was also no interaction between the speaker's success or its quadratic term and the probability of imitating the previous speaker ($Ps > 0.1$).[2]

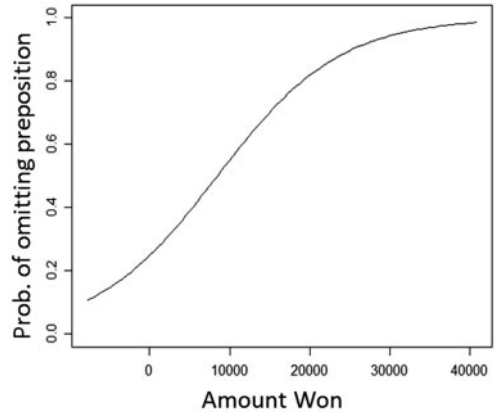

Figure 1. Probability of using the less frequent structure (without a preposition) as a function of amount of money won until that point in the game.

These results provide support to the hypothesis that reliance on linguistic norms depends on the speaker's success in the environment. It shows that success, as reflected by the amount the speaker had won, reduces the propensity to rely on conventional patterns, as indicated by lower likelihood to use the frequent structure. One caveat is that we did not modulate success, and therefore, we cannot rule out non-causal explanations of the effect. That said, a context such as Jeopardy is particularly favorable for testing the effect of success in the environment, as all players only have small amounts of money in the beginning. Therefore, if it were a specific personal trait of people that are good at Jeopardy that is associated with use of the infrequent structure, then this trait should have influenced their behavior throughout the game, even in the beginning when they only had little money, and we would not have observed an effect of success (especially since we used Speaker as a random factor that controlled for individual differences).

An alternative explanation is that the effect that we find is a frequency effect. That is, as the game progresses, the more successful individuals pose more questions, and therefore shorten the structure more. Although we cannot completely rule out this explanation, it does not seem to be the most likely explanation. Shortening effects are argued to be due to accessibility, not pure number of times one person utters the term (e.g., Fowler et al.

1 If the quadratic term and its interaction are removed, a model that includes slopes for both Previous Speaker and Amount Won for both the Speaker and Episode random variables can converge. That model shows an effect of Amount Won ($\widehat{\beta}$= 0.01, SE = 0.003, $Z = 2.77$, $P < 0.01$) as well as an effect of Previous Speaker ($\widehat{\beta} = -0.4$, SE = 0.2, $Z = -2.01$, $P < 0.05$) indicating alignment with the previous speaker. The two factors do not interact.

2 As amount of money won, and therefore success, increases with time, we also ran another analysis with time into the game as a covariate. Time was coded as the question request number, as question requests appear in fairly regular intervals throughout the game, and relatedly, the number of question requests per show is quite consistent across shows ($M = 57$; range: 53–59). Adding this variable led the model to fail to reliably converge (i.e., false convergence error) unless several slopes were removed. Importantly, Time was not a significant predictor in these analyses (all Zs < 1.5), and we therefore opted to not include it in the analysis we report above rather than report a non-saturated model. The effect of Amount Won was always in the same direction in these analyses, although it was in some of these models only marginally significant. Additionally, as it is possible that a winning player will be further removed in time from the last utterance of the previous speaker, because a winning player may have more correct responses in a row, we also ran an analysis with Elapsed Turns entered as a covariate. Elapsed Turns did not have any effect ($Z < 1$), and did not influence the significance of the other effects.

1997), and should therefore also be influenced by the number of times other players have posed questions. Yet, as described in footnote 2, our results were not driven by the number of questions that had already been asked. This, then, suggests that the results are due to a change in people's behavior as they manifest increased success in the game. At this point, however, we cannot distinguish between a change that is causally due to success and a change that is due to something that correlates with success, such as mood. We will return to this point in the general discussion.

Another interesting aspect of our results is that they suggest that while success modulates reliance on linguistic norms, it does not modulate adjustment to the immediate environment, as the amount won influenced likelihood of using the frequent structure but did not interact with the likelihood of imitating previous speakers. At the same time, speakers demonstrated only modest and statistically insignificant learning from the immediate environment, even though this is a common phenomenon (e.g., Giles et al. 1991; Pickering and Ferreira 2008). One potential reason for the relatively small effect of alignment might be due to the nature of the interaction. In Jeopardy, players do not talk to one another but to a third party—the host—and it is only the players who select the category and amount of money, and therefore, use the relevant structure. This lack of direct interaction might reduce alignment. Indeed, alignment has been shown to be of greater magnitude in dialogs versus situations in which speech is overheard (Branigan et al. 2007). The situation in Jeopardy is quite different from the one in studies showing reduced alignment with overheard speech, as the relevance of the overheard utterance is very high for the overhearers in Jeopardy. Still, it is hard to know whether it is indeed the case that success modulates reliance on patterns in the life-long environment but not in the immediate environment, or whether the selective influence is due to the fact that the situation was one in which adjustment to the immediate environment was relatively small. In Study 2, we created a more interactive environment, and tested whether adjustment to the immediate environment is modulated by success in such circumstances.

3. Study 2

Study 2 tested the role of success on adjustment to the immediate environment in an environment that is likely to induce such learning to a greater extent than the game of Jeopardy, namely in an interactive setting. Specifically, we examined the grammatical choices of French participants in the laboratory, using a modified version of the game Go Fish. The goal of players in this game is to complete sets by obtaining cards from the other players. In our version of the game, the cards were not labeled, requiring participants to provide full spontaneous descriptions of the cards. All the cards in all the sets were of different types of ice-cream. One element that distinguished different cards in the sets was their flavor/color. There are two ways to refer to these properties in French: by using a proposition, as in *la glace à la vanille* and *la glace en blanc*, or without a preposition, as in *la glace vanille* and *la glace blanche* (the vanilla/white ice-cream).

Similarly to Study 1, we measured participants' success as the number of cards in their possession. We also coded which structure the previous player in the game used. This laboratory game task, unlike Jeopardy, is social, and involves interaction between speakers. Furthermore, players in this game take cards from each other, thus directly lowering each other's performance. Therefore, we expected that in this case the influence of the previous player's utterance would be modulated by the player's success.

3.1 Method

3.1.1 *Participants*. Twenty-nine native French speakers participated in nine small groups of three to four participants.[3] Each participant participated in only one session. All participants received a small fee regardless of how many sets they accumulated in the game.

3.1.2 *Procedure and design*. Participants played a modified version of a Go Fish game. In this version there were four sets, each with six cards displaying ice-cream. At the beginning of each game, cards were distributed evenly between participants. Participants did not know which cards the other participants held. Their goal was to obtain cards from the other participants in order to complete as many sets as possible. Participants did so by requesting the cards they were missing from other participants. They were free to ask from any of the other participants. If the addressed participant had the

3 This study was originally designed for other purposes, and is reported elsewhere (Lev-Ari and Peperkamp 2014). The original study manipulated the product of the game, ice-cream versus beer, and therefore included a total of fifty-seven participants in eighteen sessions. As the beer condition had very minimal variation (the preposition was omitted 98% of the time), we do not report it here. However, if the analysis is conducted over the entire data set, the results remain the same.

requested card, she had to hand it to the requester, and the requester could ask for another card from either the same or a different participant. If the addressed participant did not have the requested card, the turn would end. Unlike the traditional Go Fish game, where the turn moves to the addressed participant, turns progressed in a fixed clockwise order to ensure that all participants had at least one opportunity to speak in each round. Once a set had been completed, participants could no longer request cards from it. The game ended once all sets had been completed. The sessions were audio-recorded for later analysis.

3.1.3 *Coding*. We checked each utterance for the appearance of a flavor (e.g., *vanille*, 'vanilla') or color (e.g., *blanc(he)*, 'white'). There were 244 such utterances. For each utterance, we coded whether the chosen structure (preposition, no preposition) was the same as the one used by the previous participant. Fourteen utterances were excluded from analysis because they were produced by the first speaker in the game, and therefore could not be coded for repetition of a previous structure. For each utterance, we also coded how many cards the speaker had at that point (Cards Won).

3.2 Results and discussion

We ran a logistic mixed-model analysis (Jaeger 2008) with Speaker and Play Group as random variables and Cards Won, including its quadratic term, Previous Speaker (contrast coded: used a preposition coded as 0.5, did not use a preposition coded as −0.5), and the interactions of Previous speaker with both Cards Won and its quadratic term as fixed factors. The dependent measure was a binary coding of whether participants repeated the structure of the previous speaker. The random structure included intercepts for Speaker and Play group, as well as slopes for Cards Won, and Previous Speaker for both the Speaker and Play Group variables. Results show a marginal effect of the quadratic term of Cards Won ($\widehat{\beta}$=0.08, SE = 0.04, $Z = 1.93$, $P < 0.06$), but importantly, significant interactions of Cards Won and Previous Speaker ($\widehat{\beta}$= −0.60, SE = 0.30, $Z = -2.01$, $P < 0.05$), as well as of the quadratic term of Cards Won and Previous Speaker ($\widehat{\beta}$= 0.26, SE = 0.07, $Z = 3.46$, $P < 0.001$). As Fig. 2 illustrates, at low levels of success, as when the speaker lost more cards than they won, they mostly use a preposition if the previous speaker has done so, but are much less likely to do so if the previous speaker omitted the preposition. As success increases, however, speakers become less influenced by the structural selection of the previous speaker. Additionally, equal increases in absolute success affect behavior more at low than at high levels of success, showing a diminishing effect of success on learning from the immediate environment.

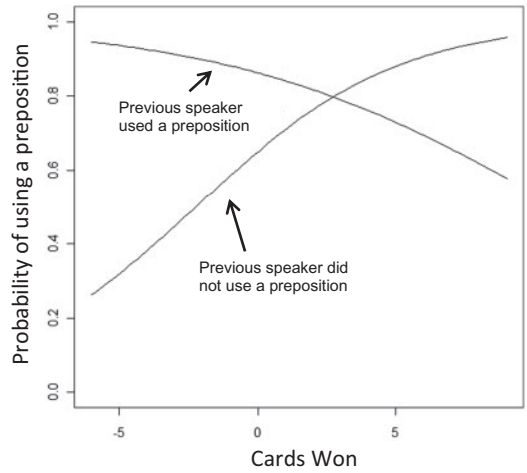

Figure 2. Players' probability of producing the structure with the preposition as a function of the number of cards won and the structure that the preceding player has produced.

The laboratory game task, then, provides converging evidence for the role that non-linguistic success plays in modulating linguistic behavior. There is also an informative difference between this study and the previous one. In particular, while players in both studies showed adjustment to the immediate environment, as indicated by repetition of the structure that the player before them has used, it is only in the more socially interactive context of the present study that this tendency was modulated by success in the game, such that the less successful players were, the more likely they were to repeat the structures in the environment. This suggests that the nature of the context, and in particular, the degree to which it is social, can influence how sources of information are used and relied upon. In the present study, the structures that were used did not have clear differences in their frequency, preventing us from examining the relative importance of linguistic conventions versus immediate environment. Further studies are required to understand better how the aspects of the environment might influence their relative importance and the way it interacts with success.

4. General discussion

Individuals adjust their linguistic representations according to the input they receive from the environment. Although, logically, individuals should adjust more to the environment the more poorly they perform in it, this principle has never been tested regarding language

learning. As general success in the environment often does not directly depend on linguistic performance, one might expect that it would not play a role in most cases. Using both transcripts of a TV show and a laboratory task, we found that reliance on linguistic patterns in the environment depends on success, such that reliance on both learned linguistic norms and patterns in the incoming input decrease with greater success. Furthermore, our results suggest that the way that success modulates behavior depends on the context, and, in particular, on how social it is.

How, then, does the effect of success come about in our studies? One possibility is that success did not influence structural alignment but that people with certain learning tendencies are more or less likely to succeed in games. As we explained in the discussion of Study 1, this option is unlikely, as the structure of the tasks meant that all speakers started out with the same, low, amount of money or cards, and thus, with equally low success, as it was defined. Since personal traits are constant whereas level of success changes throughout the game, our results cannot be explained by personal traits, and more so, any effect of personal traits would mask the effect of success, making it harder for us to find it.

An alternative interpretation that we cannot rule out is that success correlates with another variable, for instance, mood, and that it is the latter that influences structural learning. It should be noted, though, that in real life, success is likely to be accompanied by positive mood, and failure, by negative mood. Furthermore, the effects of mood are argued to come about precisely because mood provides individuals with information about their success in the environment (Schwarz and Clore 1983; Bless and Fiedler 2006; Clore and Huntsinger 2007). Thus, even when bad mood accompanies low success and seems to exert an influence on performance, it might do so only because it is an indicator of low success. What our studies show is that individuals are more likely to rely on life-long linguistic patterns and linguistic patterns in the immediate environment when they are in situations in which they exhibit lower success.

This study also adds to the burgeoning literature that shows an influence of non-linguistic factors on structural alignment. Although research on alignment at other linguistic levels examined the role of non-linguistic and non-cognitive factors (such as status) in modulating alignment, the research on structural alignment focused mainly on questions regarding the abstractness of the representation, the level at which structural elements compete during sentence formulation and so forth, thus mostly neglecting an examination of non-linguistic factors. Our results show that non-linguistic factors participate in the process of evaluating and selecting among possible grammatical structures.

4.1 Implications for language change

Adjustment to the environment can lead to long-term changes, as has been argued with regards to findings from research within the framework of communication accommodation (Trudgill 1986; Niedzielski and Giles 1996; Pardo et al. 2012, but see Hinskens and Auer 2005). The present results therefore suggest that linguistic changes might be more likely to come about at difficult times, when success is low. Is there any evidence that this is indeed the case? A full study that compares the rate of linguistic change across different times and regions while controlling for confounds and alternative explanations is beyond the scope of this paper, but there are suggestive examples that are in line with our claim of accelerated linguistic changes during difficult times. We will briefly discuss three case studies.

One type of a particularly difficult time is war time. Raumolin-Brunberg (1998) proposed that war times are likely to accelerate linguistic changes. In accordance with this proposal, she provided data concerning changes in the pronominal system in English during and immediately after the civil war in UK. Based on an analysis of letters written between 1620 and 1681, she showed that during those years several changes in the pronominal system were evident, such as a rise in the use of *its* for inanimate nouns, and the use of compound pronouns with *body*, such as *anybody*. Raumolin-Brunberg (1998) proposed that war times are likely to accelerate linguistic changes because they lead to the severance of strong ties and the creation of weak ties. In particular, she argued that weak ties were created during the civil war because men joined large armies and interacted with many people they never met beforehand. She did not provide, however, any evidence that weak ties were indeed created or that the changes in the pronominal system were driven by the creation of such ties. As her analyses indicate that most changes were driven by female rather than by male speakers, an alternative explanation worth investigating is that the reason that linguistic changes are accelerated during war times is because difficulty influences the manner in which people process information, and increases adoption of forms in the immediate environment, thus facilitating the spread of linguistic changes. At present, we do not have any evidence regarding the root cause for the acceleration of changes during the war, but we note that this is one plausible account of the effect of war time on the spread of linguistic changes.

Another piece of evidence that is in line with the hypothesis that wars in general, and the civil war in UK in

particular, accelerated the spread of linguistic changes comes from a study that examines the emergence of preverbal *only*. Nevalainen (1986) compared the use of *only* in three 60-year periods, 1500–1560, 1570–1630, and 1640–1700. Although *only* occasionally appeared preverbally already in the earlier periods, it was during the latest period that this position became dominant. This acceleration coincides with the time of the civil war, 1642–1651. As in the previous case, we cannot know whether the acceleration is due to a modulation in manner of processing and adoption of patterns from the immediate environment, but the pattern fits with such an account.

Wars are not the only type of difficult times that can lead to acceleration in the spread of linguistic changes. Economic downturns might exert a similar influence, and more so, the greater their negative influence. The Great Depression presents such a case, according to the findings of Cook (1969), who examined the pronunciation of/aw/ across two generations in different locations in Utah. He concluded that the fronting of/aw/started about 40 years prior to his study, and that the rate of its spread was higher in Salt Lake City than in Milford and Minersville. Johnson (1976) re-analyzed his data, quantifying the rate of change in Salt Lake City and Milford, and concluded that the rate of change was indeed about twice as fast in Salt Lake City than it was in Milford.[4] Both papers also date the change to the time of the Great Depression. Cook (1969) interprets the faster spread in Salt Lake City compared with the rural area as being due to the fact that this is an urban dialect that is affecting the surrounding rural areas. That said, even at the earlier time, residents of the rural area occasionally fronted their/aw/, and the pattern was of increased fronting among all speakers, only progressing more quickly for residents of Salt Lake City, without any development of a rural versus urban differentiation. Although we cannot be sure what the reason for the accelerated change in Salt Lake City versus the rural communities is, one possibility is that the Great Depression exerted a stronger influence on the urban than the rural population. Unfortunately, exact statistics about unemployment rate and other economic conditions are difficult to find for these two locations. Existing data, however, indicate that Salt Lake City started encountering economic difficulties already in 1925, leading to negative migration of 5,000 by 1930 (Sillitoe 1996). Things continued to deteriorate with twenty-five banks in the city closing between 1929 and 1933 (Sillitoe 1996). Although the situation in the rest of the country was difficult as well, data from Bradley (1999) suggest that Beaver county, where Milford and Minersville are located, has fared better than other locations. First, because residents had farm animals, hunger was not a problem as it was in other regions. Second, the early 1930s saw discovery of ore reserves in the area, leading to increased mining activities. Additionally, the area saw a growth in the dairy industry at that time, and experienced positive effects of different governmental programs, including benefits to the area as a result of the settlement of a Civilian Conservation Corps camp in the region. In general, it was often the case during the Great Depression that cities experienced greater hardship than the country-side, which led to a reversal of the previous migration of population from rural to urban areas, as now people were migrating back to the farms in search of work (Boyd 2002). In accordance with this general trend, data on the population in Beaver county do not show a decrease but stability, with 5,139 residents in 1920, and 5,136 in 1930 (USA City Directory). All these data suggest that the effect of the Great Depression was more devastating in Salt Lake City than it was in Beaver County. We can only guess as to whether these differences are related to the spread of/aw/-fronting in these communities, but they are in line with the hypothesis that linguistic changes spread more quickly during difficult periods. They thus suggest another angle to approach the analysis of the spread of past and ongoing linguistic changes.

Before closing, we suggest two more potential implications of our findings. First, we might expect linguistic changes to spread faster when there are relatively large gaps between the levels of success of different individuals. Assuming that larger societies show greater variation in success, this hypothesis is in line with findings that show that at least some linguistic changes, such as the addition of words, happen more quickly in larger populations (Bromham et al. 2015). Relatedly, our results are in line with sociolinguistic literature that suggests that linguistic changes might be propagated by speakers who interact with others who are more successful than they are (e.g., Labov 1972, 1990). This fits with research that shows that linguistic changes from above spread according to socioeconomic status (Labov 1972, 1990). It suggests that it is those members who regularly interact with members of a higher socioeconomic status that adopt and propagate the new linguistic forms. Future research should examine these possibilities in more detail.

To conclude, we have shown that linguistic alignment depends on one's standing in the environment. The less successful individuals are, the more they rely on the linguistic patterns in the environment. In that sense, language learning is similar to the learning of non-linguistic properties from the environment, which suggests that models of

4 Johnson (1976) did not quantify the rate of change in Minersville.

language change should include non-linguistic and non-cognitive factors such as success in the environment.

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