Does social structure modulate linguistic priming?

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Abstract

This research project seeks an initial answer to whether the type of social network in which individuals are placed influences specific syntactic uses. We manipulate simple and complex language contagion in a language priming experiment. Structural priming induces a tendency to repeat a current sentence that is similar in structure to a previously presented prime. In one of two conditions (egonet-1 and egonet-5) adult participants take turns with 6 other players (confederates) in a picture description and verification game. During verification turns, they are told to verify whether the pictures on their screen match the verbal description offered by another player. In doing so, they are primed with target grammatical structures that alternate in English: dative structures (double-object dative e.g., A boy is giving her teacher an apple as opposed to the prepositional dative option e.g., A boy is giving an apple to her teacher), and transitive structures (active transitive e.g., A whale is swallowing the fisher as opposed to the passive transitive option e.g., The fisher is swallowed by a whale). Participants are primed with double-object dative and passive transitive structure because their use were preferred less in our baseline session. In baseline session, we assessed participants' dative and transitive production without priming. In description turns, participants must produce similar structures to describe new pictures, showing effects of structural priming. Crucially, in the egonet-1 condition subjects are primed by a single confederate with the target grammatical structure, while in the egonet-5 condition, participants are primed with the very same sentences by five different confederates. The cumulative number of priming sentences is equal in both conditions. We measure the degree to which participants are implicitly primed for the target syntactic target structures compared to baseline. If structural priming spreads via complex contagion, the egonet-5 condition should promote a greater difference from baseline in primed grammatical structures compared to the egonet-1 condition. As for results, we found a priming effect from baseline to experimental session. Both experimental groups showed a significant increase in their use of the target structure. Nevertheless, there was no significant effect of egonet. The level of increase in the target structure's use did not differ significantly between the egonet-1 and egonet-5 conditions.

State of Art

Syntactic priming refers to a general tendency for language users to produce a syntactic structure following previous experience with that structure. At an individual level, it is rather uncontroversial that repetition of word forms boosts activation of the repeated word. In particular, hearing or producing a form makes it more likely that it would be produced again in the future (Bock, 1986; Burke et al., 2004; Ferreira & Griffin, 2003), and wordforms are articulated more quickly when they have been recently produced or heard (Shields & Balota, 1991). The effect of structural priming has been observed in adults (J. K. Bock, 1986), in children (Bencini & Valian, 2008), in comprehension (Arai et al., 2007), in production (Pickering & Branigan, 1998), and across different languages (Hartsuiker et al., 2016).

In addition to individual level, research on dialogue has demonstrated that the processes of language production are sensitive to the communicative environment. There is profound evidence that co-ordinated behaviour at the semantic and lexical levels occurs at a dialog level (Brennan & Clark, 1996; Clark & Schaefer, 1989; Clark & Wilkes- Gibbs, 1986). Garrod and Anderson showed that participants tended to converge on similar types of description when describing abstract mazes, indicating a degree of linguistic alignment between interlocutors. (Garrod & Anderson, 1987). Moreover, Clark and Brennan found that participants form a temporary agreement about how to refer to an entity, suggesting a linguistic alignment (Brennan & Clark, 1996). Speakers also co-ordinate on a syntactic level in dialogue. In 2000, Branigan et al. found that speakers are sensitive to the characteristics of the communicative situation, and in particular to the linguistic behaviour of other participants during a dialog, which resulted in the syntactic co-ordination. (Branigan et al., 2000).

Although co-ordinated behaviour at the syntactic level has been studied in dyadic relationships, how this behaviour spreads in a wider social context has not been studied.

Many behaviours spread through social contact. As a result, the network structure of who is connected to whom can critically affect the extent to which a behaviour diffuses across a population. There are two competing hypotheses about how network structure affects diffusion of a behaviour. The “strength of weak ties” hypothesis predicts that like simple viral contagion, the behaviour spreads faster through a widely dispersed network. Thus, a single source of contact is sufficient to induce the adoption of a given behaviour. In contrast, complex behavioural contagion is the process in which multiple sources of exposure/contact are required before an individual adopts a given behaviour (Centola, 2010). In 2010, Centola investigated the effects of network structure on health behaviour through artificially structured online communities. He found that change of health behaviour was much more likely for people who are placed in complex network compared to individuals in simple network. In light of previous literature, our question is “Does human language spread primarily as a virus? Or as a form of complex behavioral contagion?” Our main goal is seeking an initial answer to this question by examining whether the type of social network in which individuals are placed influences specific syntactic uses (Lou-Magnuson & Onnis, 2018)

This research question will contribute to making more explicit the social mechanisms of language spread, and establish a much needed connection between individual mechanisms of language use (such as the well-known effects of syntactic priming) and social mechanisms of language diffusion in a community.

I. Objectives

The main purpose of this research project is to understand whether social network that the individuals are placed in affects linguistic behaviour. To examine the relationship between these two variables, we previously employed an online picture description game where the participants were primed with passive syntactic use. We could not find significant results. We discussed that the lack of significance may be related to the design of our task. Therefore, the aim of this study is to investigate the effect of social network on syntactic priming with an improved task while implementing an additional syntactic form: ditransitive.

Syntactic structure typically targeted in syntactic priming research are dative constructions (prepositional dative vs double-object dative) and transitive verbs (active vs passive construction) (e.g., Bock, 1986). In the current study, two mechanisms of syntactic use were investigated: dative and transitive diathesis. There were two conditions: egonet-1 and egonet-5. In both conditions, participants interacted with 6 other (confederates, unbeknownst to them) people. In egonet-1 condition, the participants were primed with passive and double object forms by one person while in egonet-5 condition, the participants were primed by five people. Participants' production of dative and transitive structures was assessed in a baseline session before moving on to the experimental session.

In line with our hypothesis, if the social structure in which participants are embedded modulates their linguistic behaviour, we expect to find a difference between the two egonet conditions in terms of the amount of priming. Specifically, the egonet-5 condition should promote a greater difference from baseline in primed grammatical structure compared to the egonet-1 condition.

II. Method

2.1. Participants

Participants were recruited from Prolific (www.prolific.co), an online crowdsourcing website. They were paid based on the duration of the study. All participants were 18-40 years old native English speakers. Based on the mixed effect logistic regression analysis of Mahowald et al. (2016), with 16 items and 96 subjects, and without lexical overlap, it is possible to obtain .81 power to detect a true effect size of .51. Therefore, 96 participants were recruited. 15 participants were excluded from the study as they realized that the experiment was not interactive. One participant was excluded from the study as he failed to follow the instructions of the study.

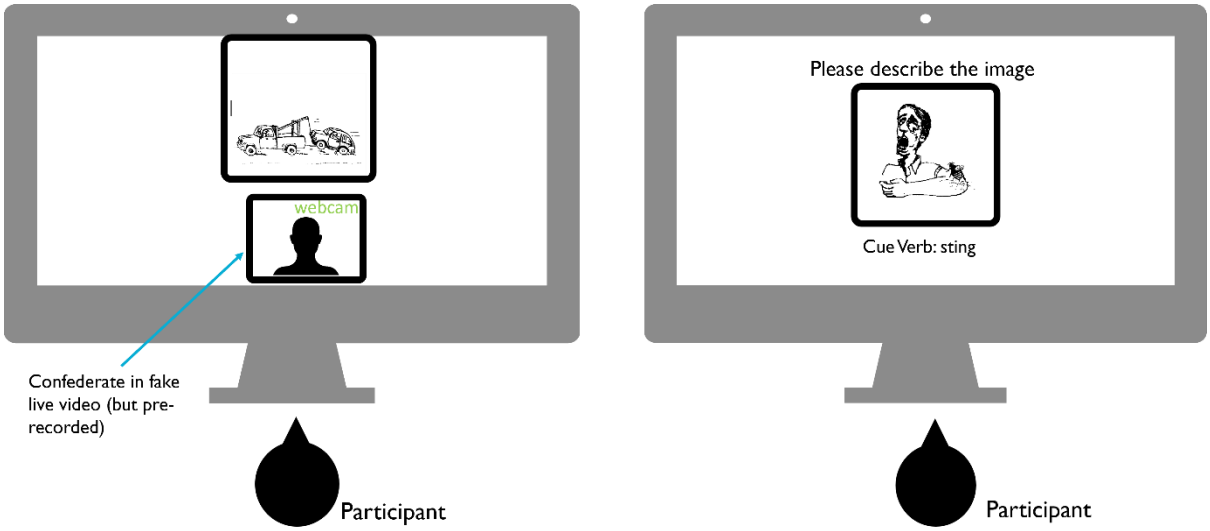
2.2. Task

The task is modelled on Bock's (1986) image description task. It involves a picture description and verification game which is played in pairs, and in turns (see Image 1). First, the participants are presented with a picture while they hear a description of that picture by another player (confederate) in a prerecorded video. After seeing the video of the other player, participants will have to verify if the picture they see on the screen fits the description of the other player. The description of the confederate is the priming. After the verification, participants will be

presented with target image and cue verb. The participants need to use the cue verb to describe the image.

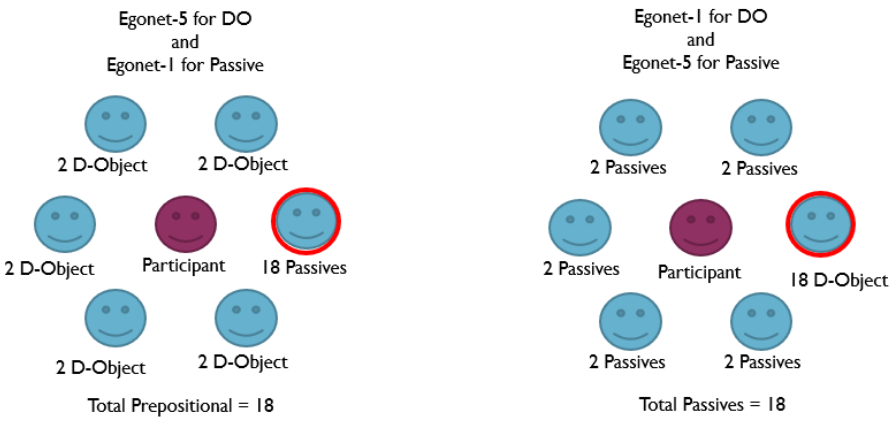
Half of the prime sentences are passive, and the other half are double-object structures as their use was less in our baseline session. Half of target images are selected to elicit simple active-transitive sentences and full passive sentences. The other half of the target pictures are selected to elicit prepositional dative sentence and double-object dative sentences. In one block, there are 2 prime and 2 target structures. All prime sentences that other players (confederates) described were in video form.

Image 1: Picture Description- Verification Task



In the first group, participants received double-object prime sentences from 5 confederates and passive prime sentences from 1 confederate. This condition was egonet-5 condition for double object structures and egonet-1 condition for passives. In the second condition, participants received passive primes from 5 confederates and prepositional primes from 1 confederate. This condition served as egonet-5 for passives and egonet-1 for double-object voice. Therefore, this was a between-subjects design where we manipulated how many different people the subject is primed from (Image 2).

Image 2: Egonet1 and Egonet 5 Conditions



2.3. Procedure

After agreeing to participate in the study, participants first completed the baseline session. In this session, participants transitive and ditransitive production without priming was assessed. After 96 participants completed the baseline session, we started to direct the participants to the experimental session. Participants were told that the purpose of the study is to understand how we communicate ideas to each other, and that they will be asked to play an interactive game online with other players. After participants completed the experiment, they were provided with a link to verify their completion.

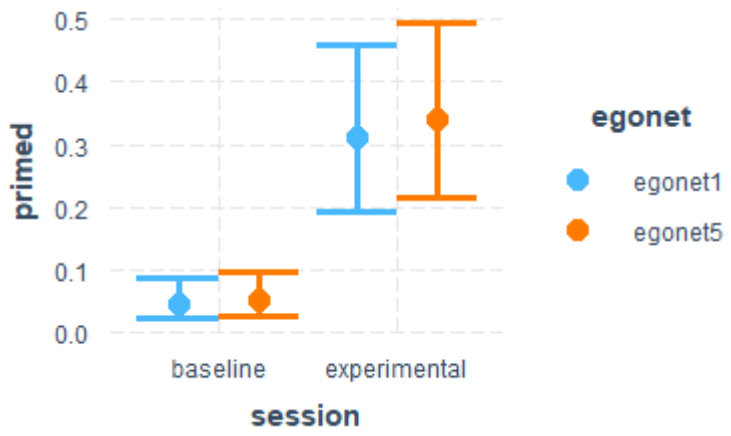
2.4. Coding

Transitive sentences were coded as active, passive or neither. To be scored as passive, a description had to involve a patient of the picture as the subject of the sentence, a verb in passive voice, a by phrase following the verb, and the agent of the action as the object of by. Descriptions scored as actives contained the agent as subject, a verb in active voice, and the patient as direct object. Neither category included truncated passives, adjectival passives and active sentences with intransitive verbs (K. Bock & Loebell, 1990). Ditransitive sentences were coded as prepositional, double-object or neither. Prepositional datives required a dative verb followed by the direct object and a prepositional phrase incorporating the indirect object; double-object datives required the verb to be followed by the indirect and direct object noun phrases, in that order. Neither category included utterances that cannot be categorized either as prepositional or double-object structure (Bock, 1986).

III. Results

Figure 1 illustrates the effect of "session" on "primed" for different levels of the "egonet" predictor. There is a clear increase in ‘primed’ in both egonet1 and egonet5 conditions from baseline to experimental sessions.

Figure 1



We adopted a Bayesian approach for model comparison. The fixed effects were the Egonet (1 vs 5) condition and Session (baseline vs primed). Also, we examined the interaction between Egonet and Session conditions. We fit and compare mixed binary logistic regressions of different complexity as follows:

model1 <- glmer (primed ~ 1 + (1 | item) + (1 | subject) + session, data = data, family = binomial)

model2 <- glmer (primed ~ 1 + (1 | item) + (1 | subject) + session + session : egonet, data = data, family = binomial)

Model 1 examined the effect of the 'session' (baseline or experimental) on primed responses while controlling for random effects at the 'subject' and 'item' levels. Session type has a significant effect (*p < 0*) on primed responses. Participants in the experimental session produced a response in the target structure significantly more compared to those in the baseline session (Table 1).

Table 1: Fixed effects for Model1

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-1.8579	0.2439	-7.617	2.6e-14 ***
session1	1.1286	0.2244	5.03	4.9e-07 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Model2 extends Model1 by adding an interaction term between 'session' and 'egonet' to examine the relationship between the independent variables and the binary outcome variable 'primed' while accounting for random effects related to 'item' and 'subject' (Table2).

Table 2: Fixed effects for Model2

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-1.85984	0.24449	-7.607	2.81e-14 ***
session1	1.13035	0.22494	5.025	5.03e-07 ***
sessionbaseline:egonet	0.06309	0.07687	0.821	0.412
sessionexperimental:egonet	0.06913	0.05037	1.372	0.17

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Model2 provides evidence for the significance of 'session' effect on the dependent variable 'primed' (*p < 0*). Specifically, 'primed' variable is associated with a substantial increase in experimental session compared to the baseline session. However, the interaction between the 'egonet' and 'session' were not found to be statistically significant *(p > .05)*.

To compare the fits of the models, we used the bayesfactor_models() function from the bayestestR package in R. Specifically, we calculated the BF for model Model1 compared to itself (as the denominator) and for model Model2 compared to Model1:

BFa <- bayesfactor_models(m1, m2, denominator = m1)

The Bayes Factor for Model2 compared to Model1 is approximately (BF = -7.2). This negative value suggests that there is substantial evidence against the inclusion of the interaction terms in Model2 when compared to the simpler model Model1. In other words, the data provide stronger support for the simpler model Model1 over the more complex Model2.

IV. Discussion

Both Model1 and Model2 emphasize the role of the 'session' variable on the dependent variable: the production of primed structure. The Model2 showed that there is no significant interaction between the ‘session’ and ‘egonet’.

Based on the Bayes Factor analysis, which quantifies the relative evidence for one model over another, we found that the Model1 is favoured over the more complex Model2. The inclusion of the interaction terms in Model2 does not significantly improve the model's fit based on our data and the chosen prior beliefs. Thus, Model1 provides a better explanation and aligns more with the observed data, as indicated by the Bayes Factor analysis.

To sum up, participants in both egonet1 and egonet5 conditions showed a robust priming effect from baseline to experimental session. This finding is important as there are very few studies that examines the priming effect from comprehension to production in an online setting. Observing a priming effect in both groups was in line with our expectations. However, contrary to our hypothesis there was no significant effect of the network that participants were placed in. The results are in favour of the Model1, where the network structure does not have a role in person’s linguistic behaviour.

There can be several explanations as why we could not find an effect of network structure. One possible factor may be related to the egonet size. The effect of egonet may be evident in a larger network where participants are primed by more people. Another explanation may be related to the measurement technique. We assessed the difference in primed production through a behavioural task, and sometimes subtle changes may not manifest at the behavioural level while still being present at the neural level. Lastly, our results may imply that linguistic behaviour diffuses through a network in a manner similar to a simple contagion. Future studies should explore the possible explanations and seek to provide further insight.

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