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Training predictive L2 processing with a digital game: Prototype promotes acquisition of anticipatory use of tone-suffix associations

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ABSTRACT

The present article introduces the concept of an educational game application aimed at providing training in predictive second language (L2) processing. The prototype of the game, focusing on Swedish tone-suffix associations, was tested during a two-week-period, with L2 learners whose native language lacked the targeted anticipatory linguistic cue. Results indicated that the game successfully promoted the learning of a novel L2 predictive strategy, as reflected in a general increase in accuracy throughout the test period and a gradually faster performance of the predictive task. More time spent on the highest level of the game was associated with greater accuracy gains. Furthermore, results suggest that perceptual training provided by the prototype even leads to improved production of the tonal cue. Implementation of the presented game concept in the form of a platform game is also discussed.

1. Introduction

Active and continuous predictive processing have been suggested to constitute a core function of the human brain (Bar, 2009; Clark, 2013), which has been linked to learning in general and language acquisition in particular (e.g. Dell & Chang, 2014; Phillips & Ehrenhofer, 2015). There is indeed considerable empirical evidence that native speakers (NSs) are able to make use of a wide range of cues to generate expectations about upcoming information at several different levels of representation during language processing (e.g. Altmann & Kamide, 1999; DeLong, Urbach, & Kutas, 2005; Dikker, Rabagliati, Farmer, & Pylkkänen, 2010; Kamide, Altmann, & Haywood, 2003; Van Berkum, Brown, Zwitserlood, Kooijman, & Hagoort, 2005; Wicha, Moreno, & Kutas, 2004; see Kuperberg & Jaeger, 2016 for a review), and even second language (L2) learners in general seem to be capable of making linguistic predictions while processing their L2 (Kaan, 2014). Intuitively, predictive processing skills could benefit L2 learners in a variety of ways, being powerful mechanisms assumed to aid in the comprehension of noisy and ambiguous input (Kutas, DeLong, & Smith, 2011; Pickering & Garrod, 2007), rapid speech processing (Lau, Holcomb, & Kuperberg, 2013), as well as potentially facilitating L2 acquisition itself due to their proposed essential role in learning. Nevertheless, learners appear to be more restricted in their anticipatory processing in the L2 relative to NSs, especially if they are at lower proficiency levels, the predictive cue is absent in the native language (L1), or the predictive

Abbreviations: L1, native language; L2, second language; NS, native speaker; RT, response time.

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information is more complex (Dussias, Valdes Kroff, Guzzardo Tamargo, & Gerfen, 2013; Mitsugi & MacWhinney, 2015). Focused training in specific L2 predictive processing skills might therefore be advantageous for a wide range of L2 learners and it could contribute to more native-like processing of the L2. The present paper introduces a game application currently under development, which aims at providing such training for L2 learners. It also reports on testing the prototype of the game.

The game mechanics have been designed to facilitate learning of specific predictive language processing strategies, by requiring the player to form expectations about upcoming speech input based on a cue and providing immediate feedback on the accuracy of this prediction in the form of actually experienced input. The key features of the game mechanics were developed by drawing on results from previous research on NS and L2 predictive language processing. In its current implementation, the game focuses on Swedish tone patterns realized on word stems, which constitute predictive cues due to their associations with specific immediately following grammatical suffixes. The game trains L2 learners to use such stem tone patterns to anticipate upcoming suffixes during online speech comprehension, i.e. to apply a predictive strategy similar to that observed in NSs of Swedish (Roll, 2015; Roll, Horne, & Lindgren, 2010; Roll, Söderström, & Horne, 2013; Roll et al., 2015; Söderström, Horne, & Roll, 2016; Söderström, Roll, & Horne, 2012).

In an experiment, we investigated if playing a prototype implementing the discussed game mechanics would promote acquisition of the trained L2 predictive strategy in low-proficient learners whose native language lacked the specific language feature (tone) with predictive value. Therefore, the investigation aimed at determining whether L2 learners showed improvements in carrying out the task constituting the essence of the game after a two-week-period of play, as reflected in their speed and accuracy of performance. Furthermore, the study tested whether such perceptual training would lead to gains even in L2 speech production, manifested in more native-like production of the language feature constituting the predictive cue. The experiment and its results are presented below. A more complete version of the tested prototype, implementing the game mechanics in the context of a platform game, will also be introduced.

1.1. Predictive processing

In cognitive neuroscience, there is an increasingly growing emphasis on predictive processing as an essential computational mechanism of the brain, shaping and supporting the perceptual system and even underlying action (Bubic, von Cramon & Schubotz, 2010; Clark, 2013). Within this framework, sensory processing is often seen as being realized in a hierarchically organized system, with higher, more abstract levels constantly generating predictions about the probability of activities at lower levels, based on hypotheses drawn from previous knowledge as well as the current model of the context. Subsequent matching of the prediction to the actually experienced input may result in the detection of discrepancies, constituting a prediction error. Information from such an error signal can then be used at higher levels to adjust the functioning of the system in order to minimize the discrepancy with subsequent predictions (e.g. Clark, 2013; Friston, 2005). The result is the modification of processing mechanisms and/or behavior and as such, this prediction-feedback cycle has been suggested to constitute an essential learning mechanism (e.g. Schultz & Dickinson, 2000). Ongoing predictive functioning of the brain would provide the further cognitive benefit of freeing up resources from processing what is predictable, which would enable the individual to concentrate on the unexpected, discovering new things to learn. Also, in cases where prediction of stimuli facilitates task completion, this mechanism could guide directed allocation of attentional resources (Bar, 2009).

Along these lines, several models and accounts of language processing involve prediction or expectation as a core mechanism (e.g. Chang, Dell, & Bock, 2006; Levy, 2008; Pickering & Garrod, 2007), and there is now compelling evidence that NSs anticipate, at least to some degree, upcoming information prior to encountering the actual input (Kuperberg & Jaeger, 2016). For instance, contextual visual information in combination with the semantics of verbs and nouns has been found to facilitate anticipatory selection of likely upcoming arguments (e.g. Altmann & Kamide, 1999; Kamide et al., 2003). Comprehenders were also reported to anticipate certain specific properties of expected input such as gender class of upcoming nouns, based on inflections on preceding adjectives (Van Berkum et al., 2005) or gender-marked articles (Wicha et al., 2004). Speech comprehension might even involve the generation of more concrete sensory predictions concerning, for instance, the phonological form of expected nouns (DeLong et al., 2005) and orthographic forms cued by syntactic structure of the preceding context (Dikker et al., 2010). NSs have also been observed to use prosodic cues to predict syntactic structure (Roll & Horne, 2011), upcoming argument (Weber, Grice, & Crocker, 2006), to generate pragmatic inferences (Kurumada, Brown, Bibyk, Pontillo, & Tanenhaus, 2014) and to anticipate upcoming inflections (Roll, 2015; Roll et al., 2010, 2013, 2015; Söderström et al., 2012, 2016).

In addition to the nature of the predictive cue and anticipated information, available time also appears to be an important factor modulating anticipatory behavior in NSs (Wlotko & Federmeier, 2015). Temporal constraints seem to affect the degree to which more complex cues can be used for generating predictions (Phillips & Ehrenhofer, 2015), as well as the extent to which information even at lower levels of representation is pre-activated (cf. Kuperberg & Jaeger, 2016).

1.2. Predictive processing in an L2

Applying predictive strategies during the comprehension of an L2 could be thought to provide various benefits for the learner. For instance, generating expectations about upcoming information and linguistic structures based on what has just been processed, and then subsequently evaluating the correctness of the prediction by matching it against the incoming input provides a way of testing one's knowledge about the L2 and learning about various dependencies in the language (Phillips &