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NEUROSCIENCES INFORM SECOND LANGUAGE ACQUISITION
Upgrading EFL educational settings with social modeling and observational learning

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Abstract – As research in cognitive psychology and neurosciences develops new models to describe the acquisition and emergence of cognitive skills, these findings call for an adjustment of EFL (and general L2) didactic approaches. The discovery of mirror neurons and social modeling theories have marked a turning point to understand the cognitive processes underlying language perception and L2 learning. This article provides an overview of the recent findings in the field of neurosciences and cognitive psychology and discusses their effects on language acquisition, with special reference to EFL learning, by taking into consideration the critical role played by emulation and the continuous improvement and spreading of technology. The article aims to provide food for thoughts in light of an interdisciplinary informed didactic approach to second language learning, with special reference to the implementation of modeling in EFL learning environments.

Keywords: Observational Learning; social modeling; SLA; EFL learning; TEFL.

1. Introduction

According to the CEFR (2011), language users and learners are seen as 'social agents' who perform linguistic activities within other non-linguistic activities, in order to achieve goals or accomplish results, all being embedded in a wider social context. In this perspective, the main goal of training is to acquire competences that allow language users to perform communicative actions in different contexts.

For several decades the theory of instructional scaffolding (Ninio, Bruner 1978), grounded in Vygotsky's zone of proximal development (1986), has led pedagogy, in the attempt of providing learners with resources and materials that could support and guide them in the development of cognitive and social skills (Sawyer 2005). Support advocated by instructional scaffolding in the zone of proximal development can be delivered via sensory, motor, and verbal channels.

In order to provide learners with a comprehensive and eclectic array of scaffolding tools, it is of utmost importance to take into account latest findings in the field of neurosciences and cognitive psychology, when developing didactic approaches to second language learning. The discovery of the mirror neuron system (Rizzolatti *et al.* 1996) and evidences for a mirror-like activity in humans (Mukamel *et al.* 2010) are undeniably consistent with research related to observational learning, especially pertaining to social modeling. Specifically, video modeling examples are increasingly spreading as a popular tool for example-based learning available on the Internet, in a wide range of forms including video tutorials, individual classes, screencasts, and Massive Open Online Courses (MOOCs).

In light of the CEFR definition of language users as social agents, observational learning in the form of video modeling applied to oral presentations seems to be a promising scaffolding tool to foster the acquisition of communicative skills. This is critical in Second Language Acquisition (SLA) and learning, in order for learners to experience and understand all cultural-bound and social aspects required for an efficient use of the foreign language in context. This review will outline research pertaining to mirror activity, language perception and language understanding, and will explore the effects of the application of imitation learning and video social modeling in EFL learning environments.

2. Perception and language understanding

Over the last decades, several models have been developed to describe processes underlying language perception and understanding, usually implying the interrelation of different neural pathways and input sources all working together to create meaning and enhance learning. An interesting example is the model suggested by Baddeley (2000), relating emotions, mind, images, and motion to the processes of understanding, memorizing and forming new skills. Hence, images can represent language sounds, letters/words, or the movements we make to write or pronounce said sounds/letters/words. Sounds and images (i.e., mental representations) are connected, implying that sensory and motor information is stored in specific areas of the brain. Connections between some of these areas, as in the case of the cerebral cortex, are in turn linked to the limbic system, affecting and steering the processes of motivation, interest and attention. Awareness and understanding are then achieved when contents stored in memory are re-projected in the areas of the brain devoted to the reception of signals (Edelman, Tononi 2013). This model allows to overcome the simplistic assumption that we passively receive inputs from the outside and extract information previously stored in our memory. On the contrary, once inputs reach perception organs, the brain areas that have information about similar processes react to these inputs, returning said information and projecting it to the primary perception area, creating an episodic buffer.

Over the years, other models have been developed to describe the process of perception and, subsequently, of language comprehension, by relating gestures and auditory patterns. According to Motor Theory of speech perception (Liberman *et al.* 1967), speech production and perception result from a biological adaptation, which is unique to the human species, and are ruled by a single synthetizing mechanism (Alexander 1962). Perception then occurs by analyzing articulatory patterns (i.e., the vocal tract gestures) rather than resulting acoustic signals (i.e., sound waves) and by inferring a virtual signal corresponding to the invariant neural motor commands (intended gestures) that trigger and precede muscular articulation, thus making intended gestures the actual object of speech perception (Liberman 1996). Motor Theory is partially challenged by Direct Realist Theory of speech perception (Fowler 1986), which postulates that when perceiving speech, people perceive directly the distal source (i.e., the speech-producing source, such as lips, tongue, etc.). The perception of the distal source does not result from a decoding operated by a specialized mental device or process, but from the acoustic signal itself that also includes information about the gestures from which it originated (Diehl *et al.* 2004). Although these two theories might disagree on whether the percept corresponds to either intended or actual vocal tract gestures, the common claim that speech perception consists of the perception of gestures is supported by a series of evidences. For example, the *McGurk effect* (McGurk, MacDonald 1976) shows how the

observation of a speaker producing speech can affect the listener/observer's perception, even when observation is not visual but haptic (Fowler, Dekle 1991). Moreover, speech imitative responses to speech perception are very fast, as the percepts (i.e., gestures) provide instructions for imitation, with significant implications for speech reproduction (Fowler *et al*. 2003). This connection between the perception of gestures and the imitation process triggers reflections on the role played by observation in speech learning in relation to speech perception, with special reference to Second Language Acquisition.

As for the recruitment of the motor system in speech perception, there is little evidence of its involvement but studies in cognitive psychology and neurosciences suggest a strong link between perception and action (Galantucci *et al.* 2006). Research on the mirror neuron system provides interesting insights on the connection between motor patterns, perception and cognitive properties. This system is made up of a class of neurons discovered in the late '90s in monkey's premotor cortex and inferior parietal lobe (Gallese *et al.* 1996; Rizzolatti *et al.* 1996) which activate both when the monkey performs an action and when it watches the same action performed by someone else. Mirror neurons activate both when the subject performs a goal-directed action or meaningless movements (Fadiga *et al.* 1995) and when the subject observes another subject performing an action. Observation triggers the activation of the motor system, enabling action recognition and resulting into an internal simulation of the action (Pineda 2005) and/or the execution of the action as an act of imitation (Iacoboni *et al.* 1999; Rizzolatti 2005). Mirror activity is not only involved in action recognition and comprehension but plays a key role in the understanding of intentions (Gallese, Goldman 1998; Iacoboni *et al.* 2005) by relating the action with the context observed in which the action is embedded. Moreover, research has found out that mirror neurons not only respond to the performance or observation of an action, but also when subjects merely hear sounds caused by specific actions (Kohler *et al.* 2002). Although there is no direct evidence of the existence of mirror neurons in humans and said existence is still debated and controversial (Lingnau *et al.* 2009; Turella *et al.* 2009), findings of neurocognitive and behavioral studies support the existence of brain regions with similar mirror-like properties in humans (Mukamel *et al.* 2010). For example, fMRI studies conducted by Molenberghs *et al.* (2012) revealed a network of human brain regions triggered in association with action observation and execution, but also in association with non-motor functions having auditory, somatosensory and affective components. Correlation between the activity registered in cortical areas during the active production of speech and the passive listening to speech has been tested and confirmed with other fMRI studies (Pulvermüller *et al.* 2006; Wilson *et al.* 2004). Other studies employing transcranial magnetic stimulation of the motor cortex observed that speech-related muscles activate during speech perception, as in the case of tongue muscles activating in response to auditory stimuli of utterances including lingual consonants (Fadiga *et al.* 2002) and in the case of activity in lip muscles triggered by speech-listening and by the observation of speech-related lip movements (Watkins *et al.* 2003). The activity of the motor cortex triggered by activity in Broca's area in response to auditory stimuli like action-related words (Tettamanti *et al.* 2005) and the comparison between words and non-words (Rizzolatti, Craighero 2004) suggests that the sensorimotor system also processes semantic aspects of language, with critical implications in the understanding of words' meaning (Fogassi, Ferrari 2007). These results suggest that the domain of this action-reaction system (whether it be a mirror or a mirror-like one) does not only cover action execution and recognition but can be extended to the involvement of the motor system in general perception (Galantucci *et al.* 2006). The meshing between perception and action has been investigated by a large body of research including, among others,

studies related to Common Coding Theory, claiming that action perception and action motor plans are represented by a *common code* (Hommel *et al.* 2001). Representations of motor patterns activated by the performance of an action are also triggered by mere perception of the same action, especially when perception occurs via observation. In a study conducted by Tye-Murray *et al.* (2013) the interconnection between speech visual perception and motor patterns related to performance (and therefore speech production) and language understanding was investigated with results suggesting that the visual input triggers motor activity related to mental lexicon representations.

In conclusion, evidences and contributions provided by research on the relationship between visual perception, speech understanding, and speech production raise interesting questions on their role in imitation learning processes. This opens the way to mixed-method studies covering the domains of language learning and SLA, to investigate whether imitational approaches, employing visual stimuli such as social modeling and observational materials, can actually enhance and support SLA and L2 learning.

3. Social modeling and language skills

Imitation is one of the basic processes through which humans learn and it occurs based on a 'borrowing and reorganizing principle' embedded in human biological evolution (Sweller 2006). According to this principle, observation enables the observer to borrow new information from the observed performer, combine it with prior information already held, and reorganize it into new information packages. According to Zimmerman and Kitsantas (2002), after observation learners access emulative learning and try to imitate the model's performance. Once they have internalized the skills and are able to apply them independently, they achieve self-control, which can evolve into self-regulation when learners can generalize this knowledge and adapt it to new situations and contexts (Schunk, Zimmerman 2007).

Example-based learning is a type of imitation learning known for its effectiveness, especially in the case of problem-solving and complex cognitive tasks, and it can employ worked examples (written walkthroughs to the task solution) or modeling examples.

In modeling examples, an animated actor (model) explains or demonstrates how to perform a task, allowing for borrowing and reorganizing concepts, with critical outcomes in the understanding of new information (Retnowati *et al.* 2017). Models can vary depending on their expertise and can provide examples either live (Bjerrum *et al.* 2013) or on video (Groenendijk *et al.* 2013). The effectiveness of this type of learning results from the fact that learners do not devote much effort in the development of a solution from scratch, but process the solving procedure in order to acquire generalizable knowledge (Van Gog *et al.* 2006), offering a valuable scaffolding option to the 'assistance dilemma', i.e., "how should learning environments balance information or assistance giving and withholding to achieve optimal student learning" (Koedinger, Aleven 2007, p. 239). Moreover, modeling examples are known to facilitate the acquisition of new skills (Van Gog *et al.* 2014) and enhance learner's self-efficacy and perceived competence in performing the modeled task (Hoogerheide *et al.* 2016). Their effectiveness relies on the Model-Observer Similarity (MOS) hypothesis (Bandura 1994), claiming that the effectiveness of modeling depends on the perceived similarity to the model. If learners perceive themselves as very similar to a successful model, they are likely more persuaded to believe that they can perform the same task as well (Mayer 2005) and acquire generalizable knowledge that facilitates transfer, i.e., the ability to apply acquired knowledge to new situations (Lachner, Nückles 2015).

Modeling is found to be an effective scaffolding tool to enhance the acquisition of complex cognitive skills, regardless whether models employed are live and/or video (Delen *et al.* 2014). Several studies have found out that learners embedded in a video-based learning environment perform better than learners embedded in non-interactive environments (Zhang *et al.* 2006), employing traditional textbooks (Merkt *et al.* 2011) or lecture instructions (Sariscsany, Pettigrew 1997).

The MOS hypothesis suggests that modeling allows for social comparison (Johnson, Lammers 2012), with an emphasis on the acquisition of new skills in response to cognitive (e.g., awareness) and behavioral factors triggered by said comparison (Hitchcock *et al.* 2003). Observation and modeling are then critical for the acquisition of social skills, since they help learners distinguish between behaviors resulting in positive or negative consequences. Social norms related to community engagement are known to be acquired through experience more than through conceptual routes (Kashima *et al.* 2013). In other words, people learn what other members do by observing the actions of their associates and tend to think that these actions engage the whole community, resulting into the adoption of a similar behavior. Based on the idea of language users as 'social agents' provided by the CEFR, the connection between language and social skills is pretty straightforward and it has been suggested that the cultural transfer of sociolinguistic competences can be facilitated by networks relying on observational learning (Doucerain *et al.* 2015). The use of the visual channel to acquire social communication skills is extremely common in learning environments involving children with Autism Spectrum Disorder (ASD). Video modeling is found very effective to let them master behaviors that they cannot achieve otherwise (Özerk, Özerk 2015) and to learn expressive vocabulary words (Gilmour 2015). The effectiveness of video modeling in learning environments involving people with special needs is a testament of the success of modeling, as an easy-to-access and affordable means (Goldsmith, LeBlanc 2004) to teach social and linguistic skills to any individual, with our without exceptionalities (Charlop-Christy, Daneshvar 2003; Charlop-Christy *et al.* 2000).

Observational learning is also found effective for the acquisition of language skills related to L1 use, especially in writing different types of texts (Braaksma *et al.* 2002; Raedts *et al.* 2008; Rijlaarsdam *et al.* 2008; Van Steendam *et al.* 2010, 2014). This is mainly due to the fact that when learning by observation, learners do not perform the learning-writing task in a self-devised way but, with peer-models especially, they observe the learning-to-write process and the emergence of peer models' texts (Braaksma *et al.* 2018), while evaluating and reflecting on others' processes, thus shifting the cognitive effort from the writing task to learning. Research showed that subjects who learn by observation organize their writing process in a more goal-oriented and analytical way in the early stages (Braaksma *et al.* 2004) and undergo a critical increase in their self-efficacy, with positive effects on their outcomes (Schunk 2003).

Several studies have reported the high efficacy of (video) modeling examples with learners of different ages and in different education contexts and fields, including mathematics (Retnowati *et al.* 2017), translation (Latorraca, 2018) and reading (Couzijn 1999).

Modeling has also been proven effective in the acquisition of skills related to literature review (Raedts *et al.* 2008) and persuasive writing (Samsudin *et al.* 2017). Learners who observed the way authors successfully supported thesis statements and subsequently emulated them were found to develop and express their ideas in a more logical and persuasive way compared with previous performance and increased their know-how of the writing and literature review processes. These results are consistent with

other research investigating the acquisition of revision skills through emulative learning (Van Steendam *et al.* 2010) reporting that observational groups perform significantly better than self-devising groups. Modeling is therefore a powerful tool that can help learners acquire complex cognitive skills and language-related strategies.

4. Observational learning and EFL learners

Drawing upon the considerations discussed above, the results of the application of observational learning to L1 learning environments (involving both ASD learners and learners with no exceptionalities) open promising pathways for the implementation of modeling in EFL education (and more generally SLA), especially in light of the CEFR definition of language users as social agents. In this social perspective, research suggests that L2 proficiency can also be increased by making learners deliver oral presentations (Adams 2004; Hincks 2010; Kibler *et al.* 2014). Oral presentations constitute a comprehensive way of putting into practice several skills related to communication, especially when a foreign language is involved, and they provide a suitable setting for the application of an observational approach. Public speaking is a critical activity related to EFL learners' L2 skills, as the many aspects involved (organization, grammar, semantics, pace, etc.) require them to apply different strategies, pertaining to memory, cognition, metacognition and rehearsal.

According to social modeling (Bandura 2005), there is a neat distinction between acquisition and performance, because the connection between the acquisition of knowledge and/or skills and their application to real-life situations is not always straightforward for learners. Social learning, informed by neuroscientific findings related to mirror neurons, can be achieved by employing not only live models but also videos, which have been proven effective by several studies (De Grez *et al.* 2014; Okada *et al.* 2014, 2017). Video modeling is a suitable approach for oral presentations, because they involve paralinguistic (e.g., posture, gestures, facial expressions), linguistic, and rhetorical aspects. Videos have been shown to affect learning by raising learners' awareness of these aspects (Murphy 2014), improving post-observation performance and learners' management of public speaking, in terms of the structure of the talk and audience engagement (Guo 2013). Video modeling is particularly effective when employing peer-models, i.e., other non-native speakers modeling a public speaking performance, as they engage learners' self-reflection (Okada *et al.* 2014) and raise their awareness of themselves and other peers (Okada *et al.* 2018), especially pertaining to error recognition and tricky linguistic aspects (Shrosbree 2008). The use of more expert models also entails other benefits. Indeed, in light of the MOS hypothesis discussed above, the observation of a model successfully performing a task without entailing any negative consequences increases the probability that the observers will emulate that behavior. With expert models, learners also experience upward comparison, resulting into an upward boost in their motivation and effort to achieve advantages by emulating the successful performance (Dumas *et al.* 2005).

In-class observational activity is not the only way to implement video modeling in an educational setting. Video blogging also constitutes a promising way to implement observational learning in EFL/ESL environments by increasing self-regulated learning and successful post-observation performance (Hung, Huang 2015). Many studies have investigated the effectiveness of blogging in L2 learning, mostly focusing on the development and improvement of writing skills (e.g., Bloch 2007; Ducate, Lomicka 2008;

Miceli *et al.* 2010). However, other research investigated the use of blogs to develop speaking skills, with positive results in EFL classes, by means of the implementation of voice blog projects (Sun 2009), audio blogs for instructor- and peer-evaluation of oral performances (Hsu *et al.* 2008), video blogs to foster communication and reflection in higher education (Olofsson *et al.* 2011), and interaction with native speakers to develop competences leading to successful communication, such as comprehensibility, fluency, and grammar (Saito, Akiyama 2017). When interaction takes place, modeling can be achieved by means of recasts, in which native models reformulate erroneous L2 speech (Goo, Mackey 2013), providing a database of videos serving as models for self- and peer-assessment. This allows learners to identify key strengths and weaknesses in their own performance and other peers', achieving vicarious reinforcement (De Grez *et al.* 2009), i.e., emulating or avoiding someone else's behavior based on the positive or negative consequences observed.

Besides the many benefits entailed, the use of peer-models in an observational EFL learning environment requires to pay attention to the management of anxiety in EFL learners. Some studies found that video modeling resulted into a decrease in anxiety, maybe due to the fact that communication is mediated by the video device (e.g., a computer) and can be asynchronous, i.e., observers' reactions are not seen by the peer models (McNeil 2014; Poza 2011; Song 2009). However, it has been suggested that EFL learners might experience increased anxiety, resulting from the fear of failure in meeting peers' expectations (Okada *et al.* 2018). Therefore, the instructor's role is critical because they way s/he introduces the observational tasks will shape how learners perceive both their own identity and other peers' identities as observers. It is crucial that observers are introduced not as judges of the performance but as learning resources, highlighting merits and aspects that can be emulated, in order to increase academic and behavioral skills.

5. Conclusions

As research in neurosciences and cognitive psychology is increasingly developing new models related to L1 and L2 acquisition, new findings call for an adjustment of EFL (and general L2) didactic approaches informed by latest discoveries in an interdisciplinary perspective. The discovery of mirror neurons and social constructivism have marked a turning point to understand the cognitive processes underlying language perception and L2 learning. This calls for an adjustment of EFL didactic approaches that are required to take into consideration the critical role played by emulation and the continuous improvement and spreading of technology. Instructional videos are currently extremely popular in both educational environments and everyday life situations, from video tutorials to Massive Open Online Courses (MOOCs). Digital technology is an ideal tool to implement social modeling in EFL classrooms, providing a wide range of virtual environments (Barry 2012). Moreover, videos provide learners with the opportunity of getting in touch with individual language variations (Godwin-Jones 2003) and are extremely suitable in a social-constructivist perspective, creating a cooperative learning environment that raises learners' awareness of their responsibility for outcomes (Chuang, Rosenbusch 2005). In light of these considerations, modeling seems a promising scaffolding tool for language learning, especially pertaining to the employment of oral presentations and video models. Oral presentations and related videos allow EFL learners to use visual information to identify their weaknesses, have more opportunities to practice their language abilities and self-evaluate their performances in order to improve their L2 skills. Oral presentations and

their video recordings thus allow for social modeling, fostering independent learning, peer assessment, with critical effects on learners' motivation and self-efficacy that are known to have a critical impact on outcomes, especially for learners at risk of failure.

5.1 Future research directions

Theories developed for language perception and understanding, together with research on observational learning and social modeling applied to SLA, raise interesting questions on the use of modeling to foster pronunciation learning, which is often a neglected area of EFL environments, due to time and tool constraints (Derwing, Munro 2005; Harmer 2001). Drawing on a pilot project developed by Aiello and Mongibello (2019) implementing a virtual environment for the improvement of English pronunciation, a new study is underway to assess whether the use of modeling in said virtual environment results in an increase of EFL learners' pronunciation competence. A sample of almost 200 learners is participating in an intensive 6-week training, performing modeled activities on a virtual platform that employs inanimate models. Subjects deliver a pre- and post-test pronunciation task that will undergo speech phonetic analysis to detect any changes in pronunciation skills after the study. The pilot project (Aiello, Mongibello 2019) revealed that learners' ratings of self-perceived pronunciation abilities increased significantly at the end of the project. The current study aims to investigate whether this increase in self-perceived pronunciation ability corresponds to a parallel change in learners' outcomes as a result of the intensive modeling-based training. Results will provide food for thought on the possibility to implement modeling activities to foster pronunciation learning in EFL environments and, to some extent, compensate for the limitations that prevent EFL learning programs to devote time and priorities to pronunciation learning.

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