Cogent Arts & Humanities

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/oaah20

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To cite this article: Hassan Banaruee, Omid Khatin-Zadeh & Danyal Farsani (2023) The challenge of psychological processes in language acquisition: A systematic review, Cogent Arts & Humanities, 10:1, 2157961, DOI: 10.1080/23311983.2022.2157961

To link to this article: https://doi.org/10.1080/23311983.2022.2157961

Published online: 19 Dec 2022.

Banaruee et al., *Cogent Arts & Humanities* (2023), 10: 2157961
https://doi.org/10.1080/23311983.2022.2157961

cogent arts & humanities

LITERATURE, LINGUISTICS & CRITICISM | REVIEW ARTICLE

The challenge of psychological processes in language acquisition: A systematic review

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Received: 21 August 2022
Accepted: 25 October 2022

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Abstract: Understanding how humans acquire or learn a language has been controversial in various disciplines. Most vigorously, psychologists and linguists have been struggling with models that would represent the processing and development of language. The current literature carries many models, making it formidable for the researchers to heed the appropriate approach. A review of the most salient models could provide enlightenment on such bewildering concerns. To this aim, this systematic review paper compares the most reliable and practical models and discusses their salience. By highlighting the requirements of a functional model to be partially universal, we raise issues for a more compelling model that would encompass areas of first and second language acquisition.

Subjects: Instructional Communication; Intercultural Communication; Language & Linguistics; Language Teaching & Learning

Keywords: Psychological processes; learning; meaning across languages; perception; first language; second language

1. Introduction

Language is known as a unique entity with particular properties. It is no wonder that no baby has ever been born speaking, except the ones in epics and ancient legendary texts. Our primary source of emergent language is a toddler's imitating phones or an infant's sounds in the prelinguistic period. The challenges when discussing language-related phenomena are formidable. In some cases, a change in a vowel in one geographical area cannot be fully traced or justified. This is more redoubtable when investigating psychological processes and incidents which happen inside our endearing brain. Unsurprisingly, we have to use behavioral and hypothetical approaches to justify our guesses about the language we employ and how we acquire it. The reason lies in the fact that we do not have direct access to the brain, its mechanisms, and its online adaptations. The number of questions in this area is infinite. However, some of them regarding language acquisition could be when a human child starts the actual perception of the received language (not the sensation or the rote reception). How do children process the input information as a language? Why is the repetition of even sounds absent for an extended period? Do children all over the world have the same processes? Are there specific stages or phases in the development of language? Why should we study language acquisition?

Apparently, neither humans have ever counted the number of words they have received and produced nor the number of processed sentences consisting of a particular form or meaning. However, there are estimated numbers of words for adults (cf., P. Bloom, 2000), which indicate the colossal capability of humans to produce and comprehend countless meaningful statements (even meaningless terms). The more enormous and extraordinary a phenomenon, the more sophisticated and questioning its components and existence may be. Hence, there should necessarily be

different sorts of accounts that describe and suggest language-related challenges. For instance, how we process the language, what stages are involved, and what relations exist between all the elements in this intriguing unified system. The acquisition of language is incredibly extensive. Thus a short overview of important issues related to language and its acquisition is required before discussing the psychological processes in language acquisition.

2. Challenges related to language and its acquisition

2.1. Endowed clean slate

John Lock's (1690, as cited in Locke, 1993; Pinker, 2004) tabula rasa for long was one of the most heated controversies in psychology and biology. The distinction between nature and nurture has long been discussed by scholars (cf., Pinker, 2004). Biology avoids discussing this dichotomy as it suggests that a mother's health and nutrition plus maturing fetal cells are necessary to shape fetal development. Children cry at birth but do not speak, yet they turn into glib talkers in nearly five years. Whether these children are equipped with a prebuilt knowledge of the language or there is a biologically programmed device responsible for the mechanisms related to language and conceptualization. Some scholars (see works related to Chomsky and his advocates) may argue that human children are innately capable of comprehending and producing language. They claim that some linguistic components, such as nouns and verbs, are wired to them. It is very contentious as many homonyms within languages stimulate our thoughts towards a challenge of why it should be the case if a human child can distinguish nouns and verbs from the very first day. Controversially, children use an identical form of a word for both "nouns" and "verbs" or " adjectives" and "adverbs" or even one word with a number of meanings. How does it persuade the language variation and loss? Up to now, we are proclaiming that this is the interaction, function, and arbitrariness of language which gives the expression structural, functional, and systematic elements that some might look at linguistic entities as a universal matter. Nevertheless, such views' approval is still questioned and needs more investigation.

2.2. How unique languages are

Languages differ in various aspects. The number of sounds, their articulation, the length of words, their classes, and their order within a statement varies. For instance, some languages are formulated as subject-object-verb (SOV), and some as subject-verb-object (SVO). More varieties are observed in their prepositions, affixes, aspects, tenses, agencies, and relations (temporal, causal, and conditional). Nevertheless, humans can understand all of them after interactions and practice (in the case of foreign languages). However, there is no guarantee that all humans be able to produce various languages they learn as their native users, in either form or meaning. Once the human picks up the patterns then it becomes an unconscious process to comprehend and produce the language with all its complexities.

The degree of difficulty of languages is another heated topic. The way that meaning is put forth across languages differs, but it is clear that this selection signifies how the users of a particular language take perspectives (Farsani, 2022). In this respect, a language can be considered simple or complex in conceptual or formal aspects (Clark, 1997, 2009; Slobin, 1973, 1985). When children (speakers of English) learn plurality, they efficiently use quantifiers to express their desire to get something more than one. By contrast, they struggle with producing the right number and the correct ending sound (they may even drop plural s). The verb and subject may not agree in some cases. Thus, the child has acquired the conceptual aspect of plurality, but not its formal aspect or its forms yet. It is evident that languages differ in these two aspects, but children, no matter what language and where, develop cognitive issues related to language at the same rate (and probably through the same stages) across the globe (Clark, 2016). By the same token, conceptual differences are expressed in different forms in various languages. It has been argued that "differences in formal complexity affect rate of acquisition" (Clark, 2009, p. 5). Although it is not widely accepted to classify a language hard or easy, some issues such as verb conjugations, adjective

conjugations, compound forms, pronouns, and even sound combinations illustrate a language as more complex on a one-to-one comparison.

2.3. Language in interaction

The situational functional aspects of language and its differences become highly salient when it comes to interactions in societies (Slobin, 1973). How words are classified in languages, differ (Clark, 2009). Likewise, how words are named, categorized, and grounded as prototypes are different (see, Meints et al., 1999; Southgate & Meints, 2001). Yet, the way words and information within a domain are related to one another are distinguishable (Clark & Wong, 2002). According to Slobin (1996), in his thinking for speaking hypothesis, children learn to think for speaking in a particular language.

In other words, language is conventionalized through exchanges that occur socially and culturally. In our idea, it is primarily based on a function that may support a usage-based or task-based approach toward the psychological processing of language. In this regard, the most major question is how children acquire these conventions. As previously discussed, it takes children years to form sentences similar to adults. It is challenging to investigate the knowledge and cognitive developments they have achieved throughout their prelinguistic age. Previous research suggests that the human child uses gestures and facial expressions prior to lexical items (refer to Clark, 1973; Piaget, 1952; Werner & Kaplan, 1963). Moreover, they use an analogy to relate similar entities to the first relevant iconic object they encounter through a process of subsumption simulated by perceptual Gestalt. Accordingly, children create rules (we may not forget that every human child is born an infant at first) or identify the existing rules. Therefore, they begin with the initial input (a word or linguistic experience). Then they add new features to it intrinsically or after receiving more input. Eventually, they come up with novel items whether words or/and thoughts, the idea is supported by Clark (2009), J. L. Bybee and Slobin (1982), and J. L. Bybee and Slobin (1982) describe the phenomenon as a sort of schematization. Nevertheless, in this study, we avoided the challenge of supporting any theory of whether a human child's learning is associated with rules, rote, schema, or analogy regarding the processing and development of a language. Instead, we pose questions so that we raise ideas and provoke thoughts in two aspects of enlightenment and stimulation.

This paper mainly discusses the literature on process-oriented (psycholinguistic) approaches. It focuses on how children access the bits of information, structures, phones, and phonemes from a holistic view towards forming a dynamic linguistic network. Phone refers "to the smallest perceptible discrete segment of sound in a stream of speech" it is "the physical realization of phonemes," while a phoneme is "the minimal unit in the sound system of a language" (Crystal, 2003, p. 347, for further details, refer to Ladefoged & Johnson, 2014; Roach, 2009). Besides, by language, sign language is also meant and we look at interaction as a multimodal communication indeed. Hence, there are more non-identical patterns in languages around the world. Several scholars have taken advantage of children's consistent correct and wrong patterns (see, Slobin, 1985; Clark, 2009, 2016). They (ibid) look at the early steps of language production in children and try to suggest feasible strategies that might be universal. The challenge of benefiting from correct and wrong versions of produced language has been widely applicable in second language learning studies (Khoshsima & Banaruee, 2017) concerning error analysis, which can be effective in language acquisition studies.

2.4. Has acquisition stages?

Taking the prenatal period for granted, newborns come into contact from the very first moment. They encounter various situations, gain ample experiences, and saliently record an ocean of linguistic input. Yet, they start to talk mostly after passing their first 366 days of observations. This may suggest that they have had two phases in their growth, one before and the other after the first utterance. These infants pass several stages to achieve a two-word communicative message, build fragmented language, make fully complete sentences, and use language for

purposes other than mere communication. This knowledge sounds favorably incremental as we, the old children, put every piece of information, experience, or language together to form a unified holistic network which is always accessible and dynamic.

Accordingly, when scholars observe the language, they need to break it into segments to investigate it. Likewise, they need to classify the whole period of acquisition into particular timetables to scrutinize the processing of age-related and compositionality information. Clark (2009) argues that throughout this acquisition period comprehension supersedes production. A longitudinal investigation (Banaruee, an ongoing study) suggests that a human child exposed to four languages (Bandari, English, German, and Persian) within his first six years never questioned the difficulty of the input. When the child sat in an English class to receive direct education, he used German words alternatively. However, he never used a Persian or Bandari to answer mistakenly, as Persian and Bandari were his parents' first languages. For instance, Notizbuch was uttered instead of Notebook, but Daftar (the Persian and Bandari for Notebook) was never misused. Hence, it is justifiable that children are fully competent acquirers of language and there might not be any stage in their level of comprehension (Clark, 2009). On the opposing side, there must be several stages (even stages within stages) to develop a full competence or system for producing the comprehended language. Therefore, it is crucial to study language acquisition in terms of how the information is processed, comprehended, and developed.

3. Perception

A widely posed question in various scientific disciplines is how a child perceives at the first moments, and what capabilities there are. An explanation of perception is crucial as the term can be defined differently. According to Crystal (2003, p. 341), perception "refers to the process of receiving and decoding speech input. The perceptual process requires that listeners take into account not only the acoustic cues present in the speech signal, but also their own knowledge of sound patterns of their language". It is challenging to judge whether children have the same perception throughout their physical growth or not since they have their own language known as baby talk or motherese in the early stages of communication. This language and its characteristics are extraordinarily bewildering. It even affects and adjusts adults' language to their own requirements (thus, probably baby-talk is more suitable than the motherese). There is no evidence of the origin of motherese language, and who suggested that adults should communicate differently with infants for the first time. Nevertheless, scholars (e.g., see, L. Bloom, 1997; Clark, 2009; Fernald, 1992; Piazza et al., 2017) support the unique characteristics of motherese language. Such research suggests that the motherese language is emotional, and this unique form of language helps children in their infancy associate the emotional sensations or meanings with the early vocalizations they receive (L. Bloom, 1997).

Piazza and her colleagues (2017) at their lab in Princeton found out that mothers consistently modified their vocalizations uniquely to communicate with their infants. It is interesting that not only they altered their pitches, words, and phrases, they even changed their timbres. Timbre is different from the pitch. According to Crystal (2003), pitch is "the attribution of auditory sensation in terms of which a sound may be ordered on a scale from "low" to "high" (p. 355), whereas timbre is related to "tonal qualities." It is "the attribute of auditory sensation in terms of which a listener can judge the dissimilarity between sounds of otherwise identical pitch, loudness and length" (p. 464). Moreover, Piazza et al. (2017) argued that this alteration of vocal timbre is not only bound to English mothers but observed cross-linguistically. Thus it is likely to consider the baby talk in this aspect a universal phenomenon. Clark (2009) suggests that this adjustment is made by mothers to break up the speech and make it manageable for the infants (probably, as mothers make the food morsels smallest so that their infants swallow and digest them appropriately). We assume that mothers already know they must reduce their cognitive load. This knowledge is based on instinct or gained through experiences as they were raised once in the same fashion. It can be fascinating to imagine that our primitive moms knew about the cognitive issues perceptually from the first day of emergence.

Nevertheless, it is conceivable to suggest that infants shape the motherese language, not the mothers. This can be investigated by recording mothers' statements for a period and observing how often they modify their words, phrases, and fragments. There is another possibility that mothers might be producing the language they received in their infancy. This could be investigated in a longitudinal study of infants that become mothers in the later stages of their life. Therefore, the mothers put the words into meaningful chunks. Saffran et al. (1996) argued that children might not comprehend these chunks in their earlier months before turning into eight months when they get to detect the frequently repeating segments and differentiate them from non-words. Accordingly, a child can process the segmentation and chunking (considering them phonetic segments) successfully earlier than establishing a connection between forms and meanings (Clark, 2009). It is unclear whether infants acquire speech through a bottom-up or a top-down process. However, they may begin with whole chunks and proceed to the segmentation. This can suggest that the acquisition and processing of a language can be holistic in nature. Nonetheless, the detection of sounds is not limited to syllables and chunks. One-month-old infants are as capable as adults of distinguishing between "ba" and "pa" (Eimas et al., 1971) and between "ba" and "da" (Bertoncini et al., 1987). Even they recognize the order of sounds, and various manners and places of articulation (for details, refer to Jusczyk, 1997; Moffitt, 1971; Morse, 1972). Research has revealed that infants are genius sound detectors. Further, they might be able to perceive sounds during their prenatal period (see, DeCasper & Fifer, 1980; DeCasper & Spence, 1986; Mehler et al., 1978; Spence & DeCasper, 1987). Studying them is of great value and importance, suggesting prenatal language exposure can be effective. Now, there is a question of whether this is a mere auditory system that tracks sounds or whether the human child is highly equipped with or specialized for processing and developing language. Mehler and his colleagues (1988) found out that unborn children had access to the language they were exposed to in their prenatal period and could recognize and discriminate their first language from the foreign ones. By the same token, Moon et al. (1993) revealed that this level of recognition is limited to the prosodic aspects of the input information. It is suggested that as soon as children find a particular liking for the predisposed language (in the immediate surroundings), they express their preference for the prosodic properties of that language (Clark, 2009). Hence, it is feasible to assume that frequency is the most salient factor in forming this preference.

3.1. Mapping

We expect children to map meanings onto what they hear and process it. This does not sound compelling to consider an infant's perception limited to the prosodic aspects of language. Still, it is unclear when it occurs, presumably, after feeling saturated and overwhelmed with the sounds. In this vein, Estes and her colleagues (Estes et al., 2007) investigated whether infants can map meanings onto novel segmented words. They found out that children in their seventeenth month of exposure to language are able to map meanings only onto objects that could be linked to a referent, but not to the novel objects. These children had to attend to the segments and prosodic properties of the non-words or the unfamiliar words. It is suggested that by age two, a human child is able to pay attention to the words which fit at the end of the expressions, even if they are new to the hearers (cf., Fernald & Mazzie, 1991; Grassmann & Tomasello, 2007).

Furthermore, children perceive sounds differently to demonstrate their auditory system's strength and to signify that they conceive the distinctions between what they hear differently. Hence, this is the change in the meaning that makes children highlight the changes in the sounds (Shvachkin, 1973). This can support that children process language representation holistically. However, it is a mystery how this representation is comprehended, and children keep every segment of sounds they hear stored in their brains. Hearing a sound, children try to judge whether a sound is novel or previously available in their treasury. Whether these sounds and their orders are innately, biologically, and inherently coded in the child's brain and all that happens is the activation or encoding of these phonotactics is challenging.

How do children map the meanings to the sounds and keep the information robustly? The perception of our language differs from the perception of sounds, which were limited in number

and order. It involves thousands of roots and affixes and borrowed vocabulary. Moreover, in the case of bilinguals and polyglots, every entity and component relevant to language and linguistics will be duplicated or multiplied. Then, is it rational to assume that this tremendous amount of information is innate? The number of codes that human DNA can carry and messages that neurons can transfer at once are prodigious. Our brain must be an enormous mega information processing monster to analyze all the input. It aligns massive information with the previously available information (imagine listening to the news, or a presidential debate in a foreign language). The problem can be figured out, to some extent, if we look at the processing matter from a holistic view and consider that all the information we receive is attached to a unified dynamic network. All of the perceiving steps would be one at a time (refer to the later sections under dynamic theories, and unified models). As explained, language and the phenomena related to it are one of the most intriguing subjects in science.

4. Psychological processes

The concrete aspect of verbal or non-verbal language has been categorized according to several stages, phases, or models that cannot be discussed all in this paper. However, a review of commonly practiced theories involved in psychological processes in language acquisition is a mandate.

4.1. Symbolism

To put it simply, linguists provide a symbolic definition of grammar when they explain language in terms, such as graphemes, morphemes, phonemes, syllables, and parts of speech. Thus, it is comprehendible to define a symbol as a discrete unit that belongs to a language system that is context-free. Based on this view, all our language is essentially symbolic, and it presents symbolic knowledge which is a collection of symbols (Hulstijn, 2002). Here, knowledge exists as an independent entity. Even though the overwhelming majority of linguistic theories have used symbolic accounts, this review is focused on non-symbolic theories. Hence, the following sections merely compare non-symbolic accounts.

4.2. Non-symbolic theories

The claims by symbolic theories regarding the discrete units of language and biological features inherent in the human child look rational and have been supported ever since its introduction (in particular by linguists). However, the more recent branches of science, such as psycholinguistics and cognitive science (and its sub-disciplines) prefer dynamic models to represent the psychological or mental processes involved in the acquisition of language. There are five paramount theoretical approaches opposing symbolic views that have gained supports lately; connectionism (cf., Rumelhart & McClelland, 1986), the competition model (MacWhinney, 1987), dynamic systems theory (Larsen-Freeman, 1997), emergentism (MacWhinney, 2006), and usage-based theories (cf., Tomasello, 2003). All these views have one thing in common: they represent non-linear dynamic models for understanding language (Dörnyei, 2009).

4.2.1. Connectionism

Connectionism is the most popular theory today among cognitive science scholars and has been employed in several disciplines that involve artificial intelligence and computational modeling. It describes mental processes within neural networks which are formed by nodes. These nodes and connections form patterns representing language acquisition, face recognition, or number learning. A desirable connectionist model can represent rule-like behavior, but not mere rules per se without a passage of symbols. On the other hand, it can represent a language system regardless of any predetermined information programming in a way that the model provides supports that human child uses the same learning mechanisms independent of an innate language acquisition device. The rule-like behavior is indeed the patterns formed by frequent input processing. Elman (2001, p. 305) argued that the main principle in connectionism is that "simple learning algorithms may be far more powerful than were previously recognized."

The reviewed studies have prescribed symbolic or non-symbolic accounts regarding word syllabification and segmentation. They were limited to their phonological or grammatical aspects. Yet, justifications become more complex and intricate when it comes to the representation of words, phrases, collections, clauses, verb patterns, and technical and figurative language. Some researchers (e.g., Hulstijn, 2002; Paradis, 2004; Pulvermuller, 2002) support hybrid models. Hulstijn (2002) highlights the role of different kinds of knowledge in learning theories, where learners pick new words and novel language even in a short exposure to that piece of information. Hence, explicit knowledge plays a different part in learning theories and can be treated differently in mental representations.

In contrast with symbolic accounts, the connectionism and its assumptions are replete with expressions such as "interactive network(s), parallel distribution(s), multiple connections, massive network, hierarchical groups or nodes, and most importantly; simultaneous processes." The basic premise about this theory comes from the nature of neurons and the way they are connected or get connected, as they inherently do not carry a discrete amount of information and sounds independent of content and knowledge (Dörnyei, 2009; MacWhinney, 2001). In other words, this is a set of neural network that gets activated in a particular pattern to present the knowledge or information. Hence, no single discrete unit carries a long-lasting property of a language or meaning. The interconnectivity of neurons through axons and synapses is confirmed in science. MacWhinney (2001) argues that activating or inhibiting information happens with the firing of neurons and it is an all-or-none fashion of information transmission. This form of inhibition is also observed in the comprehension of figurative language (Banaruee et al., 2017; Khatin-Zadeh et al., 2019). MacWhinney (2001) affirms that there is no particular method to pass down the symbols, and brain waves are not a direct means of transmitting sentences as abstract structures. Hence, a computational system capable of representing connections and activations of abstract structures sounds plausible. Here knowledge exists as a stored construct that is constructed and deconstructed when the right node in the network is passed. It is a heated discussion in scientific societies from binary distinctions of theories to spectrums or continuums where phenomena can be more comprehensively studied in a hybrid version. Several scholars (e.g., Elman, 2001; Hulstijn, 2002; Pulvermuller, 2002) suggest that a combinatory theory of symbolic and non-symbolic knowledge explains the representation of linguistic concepts more effectively, hence, a form of alignment. Pulvermuller (2002) argued that there are two levels of representation, namely low and high. In the former, elementary features of phonemes or morphemes, whether acoustic or visual, are represented using single nodes as constituents of the network. And in the latter level, forms and meanings of bigger chunks, such as words or sentences, are represented. This model is a symbolic connectionist type.

According to the nativist and advocates of universal grammar (UG), a human child is born with genetic codes endowed with language acquisition processes. Chomsky (1965) postulated a predetermined innate knowledge of language coded in the human genome. Nativism comes in support of symbolic accounts with Chomskyan generativist accounts, as they contend the inheritance of linguistic components and neural activities to produce the language, assuming the presence of a language acquisition device (LAD). However, several scholars have challenged whether UG is a language acquisition theory (see, Dörnyei, 2009; Saffran & Thiessen, 2007; White, 2007) as it does not explain how this coded bulk of linguistic knowledge is processed. This study (regardless of accepting or refuting any theory) holds a positive attitude toward pinpointing the feasible parts of every theory. This may lead scholars to design an innovative amalgamated model. By the same token, the presence of a weak form of inheritance might be inevitable as the human child naturally syllabifies the words or does motoric actions (for further details, read De Bot et al., 2007; Hulstijn, 2002; Saffran & Thiessen, 2007).

4.2.2. The competition model (CM)

The competition model proposed by MacWhinney et al. (1985) looks at the process of conceptualization from a connectionist view. It uses a distributed network of neurons to connect the form of

an input to its function; meanwhile, the comprehender unconsciously deploys multiple competing cues to perceive the received message.

A drawback of the CM was the short scope that did not include the processes in second and multilingual acquisition. MacWhinney (2005) suggested the Unified Model (UM) of language acquisition that encompassed the acquisition of any language after the first language. This model replaced parallel distributed processing (PDP) with self-organizing maps, and added the ideas of cue cost and resonance. The neurobiological fact that the higher the level of exposure and number of practices a learner receives, the more active and stronger the resonant neural connections between cortical areas will be (MacWhinney, 2008) gave weight to this unified model. Within the maps, some self-organizations establish learning. It also contains sub-processes formed parallel to the representations within the maps. This model suggests three self-organizational mapping levels: syllable, lexicon, and construction. As is aforementioned, the higher order mapping is not supported. Unified models and the CM have been criticized (cf., Dörnyei, 2009; Gibson, 1992) for being a patchwork of dissimilar doctrines (principles) and sounding more fragmented than unified. On the contrary, we assume that integrating discrete principles into one and merging them beyond a grouping or superficial amalgamation would result in a multifaceted model. Besides, the more trespassing and encroaching, the more dynamic the model will be.

4.2.3. Dynamic system theory (DST)

DST acknowledges that language, learners, and communities are complex, dynamic systems. By system, DST means groups of entities that work concurrently. Every system includes embedded interrelated subsystems. It is dynamic since it receives changes from within as an internal interaction and externally. DST considers changes at different levels in the system identical (Verspoor et al., 2011). DST assumes the existence of dependent patterns that receive feeds from necessary mental and material conditions, which become unanticipated through development. This unpredictability is the result of ongoing interactions between internal and external entities. DST presupposes humans direct this unpredictable direction to limited options using their intentions. Hence, DST is an adaptive and complex system of changes that relies on non-linear paths (Lee et al., 2009).

DST has been criticized for being unnecessarily complicated and consisting of abstract constructs and terms (De Bot et al., 2007; Van Geert & Steenbeek, 2005). Howe and Lewis (2005) define dynamic systems as time evolution, where they suggest "a system is dynamic if the value of x generated at time depends on its history" (p. 248). In other words, when a variable or component causes changes in other variables, there is a possibility of co-effects and the formation of a cycle of a cause-effect chain. The most salient feature of DST is its non-linearism that relates it to connectionist tradition. We must reconfirm that every similarity is not a concordance. Smith and Samuelson (2003) argue that connectionism is a theory of neural activities that represents how we learn statistical patterns by internalizing knowledge. While DST postulates an all-encompassing view of cause and effect for all natural phenomena. It is widely accepted that variables within a system are interrelated and have impacts on one another (De Bot et al., 2007). As language is a complex system, it is not far from mind to consider it a dynamic multidimensional layers of networks, even though it cannot provide detailed information about the process of acquisition and comprehension through current modeling. Ellis (2007, p. 23) suggests "language is not a collection of rules and target forms to be acquired, but rather a by-product of communicative processes." Slobin (1973) asserts the development of social and functional knowledge before acquiring words and sentences. This article suggests that a human child might have a multivariate absorbing system that looks for a specific form of input, something coded. DST supports researchers with theoretical key principles that are food for generating new models. First, DST is highly dependent on the initial conditions, this property props the chaos theory to postulate the butterfly effect (Howe & Lewis, 2005). Secondly, DST sees language development as a highly transient, changing, and non-linear process (Evans, 2007). Non-linearity means that no one-to-one (or linear) cause and effect factor exists. Hence, a small change (e.g., input in acquisition) may result in substantial

outcomes, while a big cause may have insignificant consequences (Vallacher & Nowak, 1999). We believe this is a good fact for producing complex models. However, the highly unpredictable and disproportionate consequences seem to be a drawback of the theory to be employed for language mechanism modellings. Thirdly, Kelso (1995, p. xi) argued that DST is a "nonequalibrium" system in a way that the formation of patterns is always possible and self-organized, thus "when the many, heterogeneous elements that produce movements-nerves, muscles, joints, metabolic processes-cooperate together in a task, they cohort together in a way that is more complex that the some of the parts" (Thelen & Bates, 2003, p. 381). According to Evans (2007), this is the cooperation of the multiple heterogeneous components of a system that results in the emergence of self-organized complex forms of behavior. Nevertheless, there is a possibility of misunderstanding self-organization and emergentism as identical processes, even though they are not one and the same (Clark, 2001; De Wolf & Holvoet, 2005). Fourth, there are attractor and repeller states in a dynamic process (Nowak et al., 2005). Attractor states are the likely (preferred) states that attract the system, while the repeller states are not preferred (Dörnyei, 2009). Hence, from a linguistic view, a conventional form and meaning creates an attractor state in a way that both interlocutors have shared conventionalized patterns. And when they receive the input with different start points, the attractor states direct it into convergent small points. In contrast, a repeller state will break the language into smaller units to find the related forms and meanings that do not share many features (Cameron & Larsen-Freeman, 2007; Plaza-Pust, 2008). This feature may support theories and models that highlight the presence of positive transfer when the interlocutors or the languages share underlying conceptual components. Fifth, there appears to be a "mutual causality" between the components that slightly form or alter one another in a system (Cameron & Larsen-Freeman, 2007, p. 233). This coadaptation is a feature of dynamic systems that gives the elements the ability to change and get changed. Child and mother (adult) interaction which results in the motherese language and the development of child's linguistic ability is a good example of this coadaptation characteristic. Last, DST pinpoints the role of idiosyncratic details in understanding psychological processing in a developmental process as DST searches for the way changes take place and what mechanisms bring those changes (De Bot et al., 2007; Dörnyei, 2009; Van Geert & Steenbeek, 2005). Thus, "noise is important" (Dörnyei, 2009, p. 107), and traditional analytical procedures that focus on average results of groups are not sufficient and explanatory of dynamic systems. Language, in nature, cannot be static. Once we accept that a word has a particular meaning, we differentiate it from others. And once we bring changes to our societies, we coin words with the inventions and innovations (Clark, 1993, 2009).

4.2.4. Emergentism

As previously discussed, emergence was a key factor in dynamic systems and connectionism. Emergentism has recently turned into a new trend and has received considerable attention from scholars (cf., Ellis, 2007; Ellis & Larsen-Freeman, 2006; Hawkins, 2008; MacWhinney, 2006). Even though emergence and emerging have been employed in various texts implying somewhat different meanings, here, however, in this review, the features or properties suggested by several scholars (Dörnyei, 2006; Stephan, 1999; De Wolf & Holvoet, 2005) form a fairly distinct definition. Hence, emergentism is a bottom-up process of interactions where local parts of the system generate more global systems. Indeed, the system will have more properties than the sum of its parts. Besides, this system should have intricate outcomes, novelty, irreducibility, and unpredictability. There is a difference between the origin of DST and emergentism. Emergentism is the offspring of philosophical schools of thought, while DST springs from mathematical conceptions. However, this study is not aimed to dissimilate theories and models which are identical in some aspects. It prefers to classify them as cooperative components in a system. Hence, the preferable view towards this DST-emergence distinction would be the acceptance of similar systems under the umbrella of connectionism. Stephan (1999) argues that a connectionist network may not necessarily represent a firm, compelling emergent form.

Nevertheless, the related literature lacks a cogent emergentist model or theory to explain the process of language acquisition (O'Grady, 2008). As emergentism and DST share similar underlying

principles and properties, these thoughts have similar problems that have a root in their unpredictability. How can a theory of language predict the processes a human child employs to acquire language? For instance, how do children syllabify the input words? Do they parse the word phonologically into discrete units? According to the aforementioned definitions and characteristics of these theories, it is not feasible to deploy them for such processes. To this aim, O'Grady (2008) argues that there should be a specific language processor that children are equipped (but not biologically) with when processing the encountered input. This property of language has been investigated in studies related to usage-based or item-based theories (Dörnyei, 2009). Usage-based theories have been suggested to be effective in investigating a wide range of linguistic studies by several scholars (Bybee, 2007; J. Bybee & Hopper, 2001; Chater et al., 2006; Ellis, 2008; Gahl & Yu, 2006; Hawkins, 2008; Tomasello, 2000, 2003). These theories, according to Tomasello (2000), explain that language is received and processed in its early stages by means of concrete syntactic categories, and "virtually all of children's early linguistic competence is item-based" (p. 156). This is the level of exposure to natural language in a functional interaction within a social and cultural context that equips children with the ability to process language. In this vein, Tomasello (2003) contends that identical acquisitional mechanisms form all the constructions of a language using three underlying processes: imitative learning, pattern finding, and construction combining. Supporters or advocates of usage-based theories argue that the frequent exposure of the frequency distribution of the items in the language input affects emerging grammar or grammaticalization. Grammaticalization has been defined in different senses (general and technical). By the same Tomasello (2000, 2003) defines it from an evolutionary linguistic aspect discussing that primitive humans turned "sequences of single symbols into grammaticized linguistic constructions" (2000, p. 162). In other words, content words are altered or formed into function words. The more a process is repeated, the higher the chance of consolidation. Hence, frequency plays a significant part in the development and processing of language (Bybee, 2002; Ellis, 2002; Ellis & Larsen-Freeman, 2006).

Questions have been posed to investigate the frequency-related phenomenon in the development and processing of language. For example, at what age and to what extent a human child starts parsing the auditory input. How does the brain map the parsed units of language to their forms and meanings? How does the frequency or exposure levels affect the language's development and processing? In this respect, some researchers argue that human child is highly capable of deciphering auditory input from the very first months (cf., Saffran et al., 1996; Ellis, 2002; Kuhl, 2004; Altmann, 2006). As it takes a human child nearly two years to start communicating with phrases and incomplete sentences, having the capability of recognizing speech features from the early stages of pre-linguistic communication can be linked to an unconscious cognitive process (Ellis, 2002). Furthermore, our brain is the only organ responsible for the computation of every linguistic and non-linguistic entity or experience, which is a crystal clear fact today. However, the detailed explanations of how this super complex organ computes the frequent and non-frequent phenomenon and how it links the novel information to the existing one and keeps itself up to date all the time is an unsolved mystery. Nevertheless, some studies provide brain capacity statistics (see, Anderson, 2000; Standing, 1973). Ellis (2002) highlights the role of frequency by suggesting that each repetition of an item may enhance the strength of the links between corresponding units. The way this frequency of items affects our linguistic behavior has been the subject of some studies (for detailed discussion, refer to Dörnyei, 2009, pp. 122–123). J. Bybee and Hopper (2001) argued that there are six major effects of frequency of distributional properties related to the phonological reduction: functional change, forming constructions, accessibility, retention of characteristics, and stochastic grammar which is experience-based.

5. Challenge of future models

The challenge of including second language learning in psychological models is formidable, so we should discuss it rather than introduce a model. Second language learning or acquisition can share similarities with FLA or dissimilate it in process and components. Dörnyei (2009) argued that L1 and L2 acquisition differ both in qualitative and quantitative aspects. He outlines the first

difference as "differential success" (p. 21). It is an attribute that highlights the satisfaction that first language learners have with the quality of their proficiency. Yet, second language learners may never attain the same quality. The second salient difference is that the automaticity of FLA sounds more homogeneous, while SLA involves diverse factors and processes (Juffs & DeKeyser, 2003). L1 is considered to involve a blending growth of knowledge of the world and language simultaneously (Ellis, 2002). On the contrary, L2 is built on a huge pre-existing knowledge of the world. MacWhinney (2001, 2004) expounds on the role of entrenchment, transfer, over-analysis, and isolation, which rely on the pre-existing knowledge and language input in learning L2. Lenneberg posed the beginning of puberty as the critical period that involves the loss of some cerebral factors effective in learning. This idea has been confirmed by several researchers (e.g., see, Feldman et al., 2002).

Bohannon and Bonvillian (2005) highlighted the role of learner-directed speech, such as motherese language, in the development of the first language of a child. This idea also confirmed the findings by Jay, 2003) and social interactionist advocates. One of the most critical theoretical differences in the type of acquisition is the implicit-explicit spectrum distinction. It moves from the implicitness of L1 to the explicitness of L2 (c.f. Dörnyei, 2009; Paradis, 2004; Ullman, 2005). Intense and deep differences should not push scholars to ignore the underlying similarities. The psychological processes and mental conceptualizations and the transfer of language concepts from L1 to L2 cannot be overlooked or underestimated today (MacWhinney, 2004), even though there are assumptions that the underlying mechanisms may differ in strength or accessibility (ibid). Above all, we cannot forget the role of the brain per se as the unique omnipresent element in learning. In other words, this is the same brain that acquires and learns whether on or an infinite number of languages. Hence, it is logical to predict that our brain and its fellow neurons and subsets use particular techniques and strategies for specific actions, which can be represented through cognitive models.

We suggest that scholars should benefit from all components and ideas of the CM but not its competition role. We believe that not only do the cues not compete with one another but cooperate using their associated connections. This is a big change in cognitive processing models, as the current models see the cues in competition. Take a language learner as an example. In case the cues or any language component compete so that the correct form emerges, the learner has to compensate too much energy for every production or comprehension. This compensation and waste of energy is not logical to brain. Our brain acts economically and benefits from the most comfortable and reliable method to operate. Its neural circuits consolidate through repetition. Thus, it is more logical to assume that brain mechanisms in processing and developing language perform in coordination. Take the word "photo" for example, there are nodes which form a pattern of network, namely; "s", "'s", "graph", "ic", "al", "y", "ly", "er", "copy", "ing", "ed". Furthermore, this is the network that represents a holistic piece of information. We intentionally use the word "holistic" to pinpoint the absence of an activation of a network when it comes to a highly discrete unit such as a phone or a phoneme. This method supports connectionist and localist networks, keeping the idea of a dynamic network, which is vibrant and incremental. Based on this approach, cooperative nodes are always linked to one another. In other words, there are relations within relations or circumstances within circumstances. Presumably, there is a big challenge in proposing an all-in-one or an all-agreeable theory as there are many aspects of brain mechanisms unknown to scientific societies. Hence, there are always two phenomena to be considered regarding the brain and its mechanisms when it comes to the comprehension and production of language that hints us the way the process ends in two outputs, intrinsic or extrinsic. This output might result from a determinant factor or underlying rules that make it come out one way or another. Accordingly, this production (which can also be intrinsic) can be the result of certain particular probabilities. Thus if we repeat the phenomena several times (or many times), it will be produced in one way or another with certain particular frequencies. Frequency plays a great part in the acquisition of language or better to say in the processing and development of information, as earlier discussed under the emergentism section. This study provided an in-depth review of the

current popular language processing and development models. By doing so, we suggested that a new way of observing the neurocognitive, linguistic, and psychological phenomena is necessary to develop cogent models in language acquisition, processing, and development. We did not introduce any specific model, but future research can be focused on developing sound and functional models.

Acknowledgements
The authors thank the anonymous reviewer for the constructive comments that led to the development of the article. The authors also thank Zahra Eskandari and Afsane Askari for proof-reading the manuscript.

Funding
This work was supported by the NTNU.

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Disclosure statement
No potential conflict of interest was reported by the authors.

Citation information
Cite this article as: The challenge of psychological processes in language acquisition: A systematic review, Hassan Banaruee, Omid Khatin-Zadeh & Danyal Farsani, *Cogent Arts & Humanities* (2023), 10: 2157961.

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Cogent Arts & Humanities **(ISSN: 2331-1983) is published by Cogent OA, part of Taylor & Francis Group.**