Acquisition of gestures in prelinguistic communication: a theoretical approach

Aquisição dos gestos na comunicação pré-linguística: uma abordagem teórica

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ABSTRACT

In order to understand the relationship between gestures and language and the relevance of gestures in the development of communicative and linguistic skills, a review of national and international literature was conducted. The analysis of data from multiple areas of science indicates the cross-influences of gesture in the evolution of the communicative competence of Humankind. The identification of the human mirror system created the background for studies that generated hypotheses about the parallelism between the evolution of gesture *versus* the evolution of language. Literature indicates that the use of gestures has a predictive power in language development, and different periods of language development influence the components of pragmatics, semantics and morphosyntax. The influence of natural gesture for communicative competence continues throughout life, since co-speech gestures have the purpose to disambiguate the content of the message to the interlocutor and to organize verbal reasoning for the speaker. Using natural gestures in promoting communication and linguistic skills in children with prelinguistic communication disorders has become essential, but it requires deeper knowledge as studies related to the early pragmatic skills are mainly directed towards the pointing gesture. Studies that analyzed other groups of gestures in older children have also contributed for understanding the use of gestures and the development of semantic and morphosyntactic competencies.

Keywords: Gestures; Nonverbal communication; Language; Deafness; Communication disorders

INTRODUCTION

Natural gestures are the primary tool of symbolic communication. Its function will be transformed over the periods of evolution of communication but it supports our communicative efficacy lifelong. These gestures are considered the first form of symbolic communication. Although not conventional or arbitrary symbols as words are, they occur repeatedly in the same physical form. Initially, their communicative force is bound to the context in which they occur but its use will confer meaning increasingly independent of context and more connected to the gesture itself.

Furthermore despite babies vocalize since birth, it is through gestures that they convey and structure their first communicative intentions. Natural gestures are the cornerstone in the construction of language as an easier way to represent the building concepts on one hand, as on another way it consists on the alternative form to express concepts when they have not been mastered on the verbal form with all the rules that are inherent in the use of language[1-4]. In sum, gestures contribute to the development of symbols and have been exploring the path to the spoken language.

Several research studies have presented evidence that strengthen the ability of the gestures being the first form of communication, and that on this basis develops language through a process of neurological, cognitive and social evolution[1,5-9]. Similarly, the ontogenic process identifies the use of natural gestures as a predictor of the emergence of language[2,10-14].

Early intervention for children with language disorders evidence focus on the importance of centralizing the use of natural gestures in programs aimed at promoting linguistic--communicative competences. Although in recent years there has been growing interest in the use of symbolic gestures[11,15,16] in prevention and intervention of children at risk, natural gestures are the more comprehensive and extensive of the group of gestures[17,18].

It is therefore necessary to gather and integrate information arising from various areas of knowledge to understand the natural gestures holistically and comprehensively.

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LITERATURE REVIEW

The literature review that follows is the result of research conducted in library collections including the Universidade do Minho, the Faculty of Psychology and Educational Sciences of the Universidade do Porto, the Escola Superior de Saúde de Alcoitão, and the Instituto Politécnico de Leiria.

A systematic search of the following electronic databases: ScienceDirect, PubMed, Scopus, Lilacs and SciELO was performed using a various combinations of keywords in Portuguese and English: gestures, natural gestures, pre-language, communication, communicative function, early language, prelinguistic, deafness, hearing impairment and signs, hearing loss, and sign language.

Within the theoretical information collected, the present study focuses on what is known about the influence of gesture on communication development. Given the variety of natural gestures identified in literature, it becomes pertinent to name and define different types of gestures.

Terminology of gestures

There are many terms used to refer to different types of gestures. This phenomenon happens because as the child developed in its communicative functions conveyed by a particular gesture, different authors chose different classifications and definitions. In this section we present several positions of different authors in order to demonstrate the variety of classifications versus similarities and parallels.

Four types of gestures can be identified before ten months[19] namely: expressive gestures, used to express emotions (e.g., clapping, tapping feet on the ground); instrumental gestures, used to control the behavior of another (e.g., reach out to ask her lap, open and close the hand trying to grasp an object while alternating eye contact between the speaker and the object); enactive gestures* that represent actions with some level of symbolism (e.g., hand beside the face representing the action "sleep"); and deictic gestures, used to show other objects (e.g., pointing)[21].

Another classification indicates three types of gestures that children use during their first communication intentions: ritual gestures, deictic gestures, and symbolic or referential gestures[4].

The ritual gestures are those that the child uses to do something about it. These gestures are transversal to most individuals from different cultures because these gestures are developed from a motor action to a social response as the child tend to end by summarizing the movement just to a gesture. For example, the act of closing the outstretched hand used by children to ask something cuts across many cultures spread across various parts of the globe. Initially the children perform repeated movements to open and close their hands in an attempt to grasp an object but as it will result in getting a response to their motion (the adult gives you the object) tends to reduce the gesture made towards another, to design a stylized version of the movement (the ritual gesture) served with communicative intent. This learning process is not dependent on observation of the behavior of the other for subsequent imitation, and does not depend on the cultural understanding of the intentions of the other. Thus, the ritual gestures are distinguished from symbolic gestures because the child is not influencing the other's attention through a mutually understood communicative act but only to achieve a concrete result[4]. These gestures seem to be more associated with communicative functions acquired earlier in connection with the satisfaction of needs.

The deictic gestures are defined as gestures designed to direct attention to the adult external entity, being the pointing gesture a prototype of such gestures. Depending of the learning process associated with the acquisition of this gesture (point) it can be similar to ritualized gestures or not.

The child can acquire the gesture by the same process described above, or may acquire it by imitate the mimic of the adults and using it on the same type of communication functions such as, for example, to comment something. In this case the child does not use the gesture just to get something, but also to exchange communication in which it is necessary to access the mental state of the other.

The symbolic gestures are used in communicative acts that are associated with a referent metonymic or iconic[4]. Such gestures are built upon the characteristics of the object or action they represent, for example, extend your arms at your side refers to "airplane" or pointing with the thumb extended in front of the open mouth to refers to "drink."

The iconicity of gestures is just perceived by adults, so these gestures are acquired through imitation in communicative exchanges with adults. Indeed, some studies show that the iconicity of gestures does not facilitate its acquisition by deaf children in the early stages of acquisition. In the second year of life children learn arbitrary gestures as easily as they learn words; children at 18 months old cannot understand specific communicative intentions conveyed by iconic elements[4].

In a study, understanding the process by which children transformed into natural gestures into language, gestures produced by the children and their mothers were categorized into three groups[14]:

- Deictic gestures used to indicate objects, people and places in the immediate context and meanings attached to the context. Observation of the production of gestures that were placing an object in the visual field of the pair was performed, and well as observations of communicative gesture of pointing to the same object with your finger or palm;
- Gestures included conventional body movements and hands, for example, extend your palm to request an object ("give"), place one or both hands on one side of the face, tilting his head ("sleep/sleep") , nod ("yes"), turn and lift your palms up ("do not know").
- Iconic gestures to express actions or attributes of concrete references through body movements or manual, for

* Terminology used in themes related with the cognitive development, in which the first level of enactive representation was the one that children represented the world through the sensorimotor actions imitating and manipulating objects [20].

example, moving the index finger in circles to indicate the movements of a ball, or by placing both palms upright on his head to indicate the shape of the ears a rabbit.

For the classification of co-speech gestures carried by hand movements are listed five types of gestures[22]:

- Deictic gestures often originated by functionality grasp objects in a particular spatial location;
- Domic gestures in which the hand moves toward representing the mouth will bring food to the mouth and referencing "eat";
- Metaphoric gestures in which the hands move to represent the manipulation of objects, e.g., pressing hands on claw refer to "crease";
- Spastic gestures that are performed by rhythmic movements of beats refer to, for example the floor;
- Aversive gestures referring to gestures adopt a defensive posture of the head and body.

Neurophysiology of gesture

The theory about the biogenetic recapitulation states that ontogeny recapitulates phylogeny. On this account we can even determine the parallelism between gesture and language evolution and the process of acquisition and language development.

The literature has been pointing relations between the pattern of communication development in children and some evidence pointing to similar patterns in the evolutionary process of humanity that allowed the emergence of communication and language competence factor for social and human characteristic distinguishing all other species[4,6]. A phylogenetic perspective, the origin of sign languages is coincident with the origin of human languages, dating back to the early philosophical discussions about the language in the beginning of Humanity[1,22].

There are indications that throughout the evolution the mirror system kind has played a key role in increasing the complexity of communication, with the emergence of linguistic-communicative system used currently[5,23] connected to multiple links between action, gesture, meaning and language[5,7,8,22,24-26]. This system is activated when an action is performed or mouth or a manual action related to an object. Also, arousing the attention is turned to observe the other to perform actions similar[7,22,26] allowing imitation.

The mirror neurons of the premotor cortex and parietal, and encode the goal of a motor action, also encode the intention behind this same action, allowing the encoding of action to pick up an object but also to grasp an object with intention of eating[26].

The studies of neuroimaging and transcranial electrical stimulation on the responses show that the relationships between actions and words are found in Broca's area[11]. This brain area is involved in the mirror system being activated for the recognition of manual actions and oral[26] and to understand the meanings present in the communicative gestures and articulation of sounds/words[8]. Indeed, the words and hand gestures that share meaning influence each other when they are produced simultaneously.

Given that the mirror system is dynamic, it activates different areas according to the action that is being observed. If the goal is to understand the message conveyed in a communicative act involving gestures associated with speech areas of the system will be activated mirror neurons different than if the intended goal is to understand speech with this visual information of oral movements[8].

The explanations about the nature of these interactions and processes are best explained in behavioral studies that advance the hypothesis of integration between gesture and word processing occur by the social intent in interacting directly with the caller, which in varying degrees of complexity needs make use codes from gestures to conventional oral[9,11].

Gestures and language: interconnections

The use of communicative gestures are predictors of language development in two ways, firstly because there is a relationship between the magnitude of the amount of objects that the baby points and understanding of vocabulary that will own in the near future, and on the other hand gives an indication of which the words that the child will acquire soon (e.g., if points to the dog and not to the bone, the likelihood is that the child acquires the word dog before bone)[3,13,27,28].

It is noted that the gestures also play a predictive role in the development syntactic, because the age at which the child produces the pointing gesture + word predicts the age at which produce two-word phrases, namely first child just points, then points to the word *food* intended to convey the message *I want to eat the cookie*. Later, develop two words that are predictable by combining gesture + word, i.e., production of the word *car* simultaneously pointing to the father, predicts phrases such as name + name, while the word *eat* while pointing to the mother predicts the phrase verb + name[28-30].

It is known that the amount of gestures produced at 18 months predicts the vocabulary at 42 months and combinations gesture + word also predict syntactic complexity at 42 months. Note that correlations were only found on gestures toward quantity *versus* number of vocabulary or word + gesture combinations *versus* syntactic complexity[28]. Thus, children who use a lot of gestures at 18 months may have lower performance in the production of syntactically complex sentences at 42 months.

These data indicate that we can predict the features of language of a child (syntax and semantics), two years in advance, just by observing the use of gestures. It indicates three possible mechanisms underlying the relationship between the use of gestures and language development: a) the use of gestures can be an indicator of the development of communicative interest on the part of the baby and the type of vehicle they choose meaning that more afternoon will be revealed in the language, b) gestures give your child a way to enter the communicative interaction before having levels of language development that support the communicative experiences (though how this process unfolds is unexplained), or/and, c) the gestures of children induce verbal language of others, and this opportunity that best explains the close relationship between the contents of the child's gestures and content of subsequent language[31].

On this hypothesis a study analyzed the responses of mothers to natural gestures that their children use to express themselves[32]. It has been found that mothers translate these gestures into words. Mothers translate the babies gestures into words or phrases promoting the relationship between what the baby think and how language can express this thought. In fact, there are indicators that gestures play a dual role in the process of language development. On one hand, they are predictive of the development and secondly, their use supports development. A study examining the use of private gestures, namely not directed to another, distinguished two types: private ostensive gestures and private pointing gestures[33]. It was found that children used them in order to regulate self-reflective and to be helpers in the way they built and organized his thoughts.

Through analysis of gestural communication system developed by deaf children (without access to oral language and native language gestures), met a number of characteristics common to all other linguistic systems used by humans, which is called, resilient properties of language[34]. It was found that when the gesture is used in order to perform all the communicative functions of speech acts, this assumes similar properties to the level of the discourse features of word and phrase. It could then be inferred that the use of gestures in children's interactions help in structuring and acquiring communicative functions? This inference cannot be linear. When the speech acts and gestures are used together, the gesture acquires a complementary function and disorganized, losing the resilience properties of speech. Only in the absence of speech acts gestures acquire greater role and structure with those properties.

In a study that asked adults to describe the scenes of an audiovisual recording, it was found that when adults used the gesture with oral language, gesture rarely matched in order consistently[35]. However, when prevented from using oral language, a form of communication with gestures combined into chains was developed, in an order of which differed from the order of the words of their mother tongue.

Studies conducted in this area are important tools for researchers to understand the process performed by the children to acquire language or in conditions like deafness or language disorders. When children have problems in conveying their message orally, they transmit their messages through gestures. In fact, all children use natural gestures, whether early language acquisition either at the beginning of the acquisition of a second language[36].

Children of early ages relate only half the objects with natural gestures (primarily pointing) supported in context, contrasting with a small percentage of references supported by words or by words accompanied with gestures[37]. The fact that the child will point to an object is predictor of learning that word, either because the gesture triggers the naming of the object by the other, either because it indicates the child's interest for the same object. Development of gesture analysis showed that the children in different sessions rarely reported orally to an object without referring to it with the pointing gesture before[37]. About 80% of the time, the first references of a child to a referent/meaning/concept was expressed through gestures, and later referenced by word and gesture simultaneously, and only later by the word. This support function of lexical acquisition is gradually abandoned as adults learn new vocabulary without requiring this process. This process is only present in the very beginning of the acquisition of communication skills. At around 26 months, in which children make their first steps in the new linguistic period, lexical entries are made directly by the word[16].

These statements account for the theoretical assumptions of social-cognitive approaches. The fact that this study did not support the influence of environmental factors for pointing/language development should be related to lack of data than the actual lack of relationship of social factors, since the comprehension and production of gesture point is the first indicator of the notions of secondary intersubjectivity, namely to understand others as intentional agents.

Pointing is only a milestone in the children's social and linguistic development since the age of 12 months[38]. A meta-analytic study showed a strong correlation between the pointing gesture and the emergence of language reporting an unambiguous relationship between pointing and skills development in comprehension and expression of language, and even more significant when the gesture is produced in a act declarative competency[2].

But children do not use only the natural gesture of pointing out. Among many other iconic gestures they use gestures that are not so dependent on context, because they are built on aspects of its referent (e.g., repeated movement to place hands under armpit to represent monkeys). For this reason they are very approximate and more closely linked to the characteristics of words. In fact, often gestures support communication in the same way that words do.

The fact is that children use gestures to perform various communicative functions, in particular, to request objects or actions, to inform (e.g., "no" in the case of absence/presence), for review (e.g., "large" in the case of the attributes of objects), and to refuse (e.g., "no" in the case of rejecting an action).

Indeed, the natural gestures are part of our daily lives that remain in adulthood, playing different roles according to the situation in which they are used. There is an effect of gesture on speech understanding in adults, as in situations where the conditions are compromised either by noise (external condition) or by deafness (internal condition), as visual information is incorporated in discourse processing[39]. The external interferences lead to the inclusion of gestural cues in a finite time period, while the internal lead to a permanent use of gestural information, possibly caused by changes in the spatial distribution of visual attention. Individuals with hearing loss tend to use visual information as a strategy to facilitate the understanding of speech, so the natural gestures that accompany speech are a fundamental tool in understanding the speech of everyday situations. In early communication stages deafness does not seem to produce differences in the use of natural gestures, so both deaf and normal children use them to communicate. There were not significant differences in the pattern of communication with deaf (profound and severe) and normal children which possessed a lexicon with less than ten words in their second year of life[40]. Although the use of spontaneous words for children with hearing loss is slightly smaller there

is a significant difference in the innovative use of gestures by the deaf children.

Throughout the development children use gestures as the transition to oral language, producing natural gestures to accompany their verbalizations, and these combinations are integrated in time and meaning. By contrast, natural gestures emerge in children with deafness in two ways, in one hand assuming support functions of natural communication, but also gradually taking over the functions of language (spoken language or sign language)[41].

The question that remains to be explained is whether communication, although both normal and deaf children use natural gestures, (perhaps the same amount) do they use them with the same functions?

When there are changes in the acquisition of language competencies functions can be altered. One possible explanation is that after the initial period in which gesture supports language acquisition, it is replaced by a complementary function of language.

Children with Specific Language Impairment** (SLI) do not use more gestures than children with typical development, although children with SLI use gestures in order to overcome their difficulties in expressing the message orally[42]. When children experience difficulties in expressing gesture acquires a more structured way (not by quantity but by the quality of gestures). This is consistent with the strategies used by adults in which by using the gesture with oral language, rarely matched the gesture chain in a consistent and orderly, in contrast with when prevented from using oral language[35].

Thus, natural gestures are effectively used throughout life to overcome the difficulties encountered in expressing ideas in words. This may not be very obvious to the observer because this function lies not in the quantity of natural gestures that are used but the type of information that is conveyed by gestures. Effectively, sign languages that support the entire communication are very different from natural gestures that accompany speech[41]. The truth is that sign languages are coded gestures with a system with all the features of spoken languages. However, natural gestures complement the oral discourse, and thus have different functions, such as to emphasize the message, among others. For children who are developing the pre-linguistic competencies, in which gestures are natural/non-coded and emerge to support the communicative acts, these gestures are presented with even more structure.

DISCUSSION

Evidence of interconnections between natural gestures and language are emerging from various scientific areas and clarify the ways in which gestures facilitate and promote communicative competencies, both in the initial development of communication and language as throughout our lives. The influence of gestures on skills acquisition is transversal to the evolution of man. This transversality phenomenon is not limited to the phylogenetic and ontogenetic perspective, which is transverse to longitudinal communicative and linguistic competencies of individuals.

Contributions from the field of neurophysiology in identifying the functions of mirror system not only shed light on aspects such as attention ability, the ability to imitate gestures and actions, but also explain how this system interconnects with Broca's area for the development of semantics.

Behavioral studies demonstrate the predictive function of natural gestures in language development, identifying their influence on semantics, pragmatics and morphosyntax.

FINAL COMMENTS

Although in the last two decades researchers recognize significant advances in the knowledge of how the gesture functions in communication, there is still many aspects to understand in relation to the development of communicative skills in children with communicative disorders. Most studies are related mainly to the pointing gestures as other studies with other groups of natural gestures are mainly directed to understanding the relationships of the components semantics and morphosyntax in older children.

Thus, future research should deepen the knowledge about the meaning, identifying and understanding the relationships between initial pragmatic competencies and use of a comprehensive range of natural gestures.

** In Specific Language Impairment there are different processes and sequences of the typical patterns of language development in absence of sensorial, emotional and cognitive deficits, as well as anatomic or motor deficits of the oral-motor system [43].

RESUMO

Com o objetivo de compreender as relações entre o gesto e a linguagem e a relevância do gesto no desenvolvimento de competências comunicativo-linguísticas foi realizada uma pesquisa da literatura nacional e internacional. A análise dos dados de múltiplas áreas científicas indica influências transversais do gesto natural na evolução da competência comunicativo-linguística do Homem. Assim, a identificação do sistema de neurónios-espelho promoveu o emergir de vários trabalhos que levantaram hipóteses sobre o paralelismo entre a evolução do gesto *versus* a evolução da linguagem. A literatura aponta que os gestos naturais possuem uma força preditiva no desenvolvimento da linguagem e ao longo de diferentes períodos influencia diversas componentes: pragmática, semântica e morfossintaxe. A influência do gesto natural para a competência comunicativa continua ao longo da vida, visto que o uso de gestos naturais simultâneos ao discurso possuem a função de desambiguar o conteúdo da mensagem para o interlocutor e de organizar o discurso ao emissor. O uso dos gestos naturais na promoção de competências comunicativo-linguísticas em crianças com perturbações da comunicação pré-linguística torna-se incontornável mas requer um aprofundamento de conhecimentos dado que os estudos relacionados com as competências pragmáticas iniciais direcionam-se sobretudo com o gesto de apontar. Outros estudos analisaram os gestos naturais na compreensão das relações com as componentes da semântica e morfossintaxe em idades mais tardias.

Descritores: Gestos; Comunicação não verbal; Linguagem; Surdez; Transtornos da comunicação

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