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The relationship between language and eye contact

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Abstract In this study we will aim to develop two ideas: (1) eye contact is an innate and important tool of social cognition which, among other things, facilitates language acquisition; (2) eye contact, however, is not essential for the development of language and joint attention.
The cost of staring into a person's eyes is the impossibility of reading her lips to phonologically disambiguate language. Nevertheless, children, like adults, gaze more at the eyes than at the mouth of their communicative partner. This study lends support to the idea that eye contact plays an important role in language acquisition as it becomes a primary means to fixing reference. The looking for eye-contact is innate; we will attempt to delineate the longitudinal development of the interest for eyes in newborns from the first few hours to two years of life.
The second idea will be developed by considering the consequences of anomalies in eye contact in the linguistic phenotypes of people with autism spectrum disorder (which affects eye-contact from two months of age) and of people with congenital blindness. In both cases, subjects show delays in language development, ToM development and deictic competence. Subjects with autism can compensate for the linguistic deficit and, through this compensation, they can also partially compensate for their deficit in ToM. Subjects with congenital blindness can compensate for all these deficits.

Keywords: word learning, eye contact, gaze following, language acquisition, autism, congenital blindness, blind, joint attention

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0. Introduction

The human being is able to grasp a lot of information from the eye in a very short time. If a man has only one second to tell you how he is, language would not be the best way to choose, a look will be far more effective. In 1997, Simon Baron-Cohen elaborated a test known as *Reading the mind in the eyes* (Baron-Cohen *et al.* 1997), later revised (Baron-Cohen *et al.* 2001). This test required participants to associate a word representing an emotion (a very complex emotion, i.e. "serious, ashamed, bewildered or alarmed"), with a photograph of eyes. Human beings that are not affected in social competences (i.e. because of some psychiatric or neuropsychiatric illnesses such as autism or

schizophrenia) are, on average, able to correctly answer about 28 out of 36 questions of this kind (Baron-Cohen *et al.* 2001).

The eye, however, does not only transmit information on the state of mind. By observing only the ocular area of other co-specifics, we are easily able to infer (with, of course, a good level of approximation) their age, their sex, which part of the world is attracting their attention at that moment. The eye analogically transmits, in just a few moments, information that does not normally find an explicit place during conversations. If a man on the street looks at you from a little distance and asks you if you know what time the shop in front of you opens, you will not ask him how old he is, what shop exactly he means or if the question is explicitly addressed to you, because his eyes already give you this information instantly.

The advantage that the eye has over language in the transmission of information is its speed; the eye is, among other things, a powerful transmitter of information with an analog operating system. Man is the primate with the most easily visible sclera: not only is it devoid of any pigmentation, but it is also greatly elongated horizontally. These differences have led to the hypothesis that man is the only primate in which the importance of intraspecific communication through glances is greater than the importance of hiding the direction of one's gaze from predators (which, conversely, has prevailed in other primates which have a proportionately smaller and distinctly darker sclera) (Kobayashi e Koshima 2001).

Of course, the digital precision of language is impossible via ocular communication, but this union of vagueness and instantaneity that distinguishes ocular communication is often particularly suited to the transmission of social messages. When a message is emotionally very salient, our eyes, together with the general bodily attitude, usually communicate it well before our words. Indeed, our eyes endow it with an exhaustive vagueness, which can, however, be derogated from. This derogation is almost always lost when it takes the precise and digital form of articulated language. This phenomenon is masterfully described by Mary Shelley, in her novel entitled *The last man*, in the scene in which the protagonist must communicate to his sister Perdita that her husband is dead:

> the words died before I could articulate them; I felt a ghastly smile wrinkle my lips. She understood my gesture; again her head fell; again her fingers worked restlessly. At last I recovered speech, but my voice terrified her; the hapless girl had understood my look, and for worlds she would not that the tale of her heavy misery should have been shaped out and confirmed by hard, irrevocable words (Chapter XIV).

The body language of the protagonist anticipated the verbal language, making the message more bearable and in some aspects still erasable. Words, on the other hand, in this case would take on the character of irrevocability.

Ocular communication allows us to associate another analogic message with our linguistic message, whether this is vague or has the precision of geographic coordinates. The former can be discordant or concordant with the latter, but the point is that having two communication systems that can be used in parallel allows us to modulate messages of extreme complexity: a woman can look sternly and tell her two-and-a-half-year-old son: «come on, throw it back on the ground» while actually meaning: «I don't want you to throw this object on the ground».

According to some researchers, the ability to follow the gaze of others is a necessary (although not sufficient) prerequisite for the acquisition of words (Gliga *et al.* 2012). We do not share this view: if this were the case people with congenital blindness would

never manage to develop language! However, as we will see, although ocular communication is not essential for human communication and does not have the same role as verbal language, it amplifies the complexity of the messages that can be enunciated in the same space of time. One element that seems to clearly indicate its importance to us is the fact that we prefer to look at a person's eyes rather than their mouth when they speak. Looking at the speaker's mouth normally favors the phonological decoding of a message, nevertheless, we look longer at the eyes of the speakers because the information they give us is more important to us than the phonetic accuracy of the message, to infer which we will use contextual information and frequently the information obtained from the eyes.

To support our thesis, we will attempt to illustrate the use of ocular communication in children from birth to the completion of the second year of life (§1). In this paragraph we will show the importance that eye communication acquires during the first 24 months of life. In the following paragraphs (§2, §3), however, we will discuss the relationship between communication and language by reflecting on two pathologies in which ocular communication is compromised: autism and congenital blindness. Both of these pathologies are normally associated with delays in language acquisition; yet in both cases an almost perfect recovery of the linguistic function is potentially possible. The case of autism will then be particularly interesting because it is associated with a widespread intolerance towards the ambiguity of communication. Returning to the example of the mother who says to her son with a frown «come on, throw it back on the ground», the person with autism will probably carry out the linguistic order literally. For individuals with autism who develop verbal communication, none of the power and digital depth of the message is precluded; but the flexibility of use of words really seems lacking.

We will conclude the article by summing up our argument (§4): ocular communication, phylogenetically precedent to linguistic communication, is associated with it, enhancing the complexity and flexibility of use of information. Linguistic communication is undoubtedly more important for intraspecific cooperation, and is ontogenetically independent of it. However, the possibility of using both communication systems favors and speeds up language acquisition and also amplifies the ability to process more complex messages. Furthermore, it is still favored in some very emotionally salient contexts.

1. Eye contact and vocal communication during ontogenetic development

Newborns are extremely sensitive to eye contact. They open their eyes within the first 20 minutes of life (Lamberg 1981). They are already sensitive to the plays of light on the faces they look at between 13 and 168 hours of life (Farroni *et al.* 2005). Newborns aged between 24 and 120 hours prefer to observe faces that have their gaze turned towards them rather than faces that are turned away (Farroni *et al.* 2002; Farroni *et al.* 2006). Newborns around 36 hours old look at a photograph of a person with their eyes open longer than that of the same person with their eyes closed (Batki *et al.* 2000). Between 2 and 5 days of life they seem to prefer the faces of those who look directly at them to those who do not (Farroni *et al.* 2006; 2002). Furthermore, the newborn's perception of the eyes seems to have a very strong influence on the parental behavior of adults (Woo and Schaller 2020). A sudden increase in visual exploration for faces is already present between 5 and 7 weeks of life; from 9 to 11 weeks newborns acquire the habit of focusing on the eyes of those who speak to them (Haith *et al.* 1977).

Intentionality seems to make its entrance into the use of visual communication at around 12 months. At 12 months, babies turn their gaze to others to communicate

(Liszkowski *et al.* 2008) and to recognize their intentions (Csibra 2003). At this age, children are able to understand that others see things (Moll and Tomasello 2004). Re-discussing a complex network of experiments, Michael Tomasello showed that the way mothers use their gaze with their children to direct attention to objects and their ability to develop joint visual focuses with them, greatly accelerate the acquisition of words (Tomasello 2008: 140-141). The gaze in this perspective has a dual role: when directed to the eyes of the child it attracts their attention, when directed to objects it becomes a deictic. A recent study also showed that children who, in the first year of life, tend to look at the eyes of others for a greater amount of time will understand more words around their first birthday and children who, during the second year of life, tend to look longer at the mouths of other speakers will have a more extensive lexicon around their second birthday (Koirala *et al.* 2020).

The stages of this path towards ocular communication in the first weeks of life appear slower than the vocal ones: linguistic sound has in fact had several months' advantage over visual inputs since the baby has already begun the journey towards language learning in the mother's womb. Despite this, the slow start in learning visual communication is largely compensated for by the length of time that the acquisition of articulated language requires. Visual communication begins after vocal communication and can begin to be used to great advantage well before the child begins articulating the first sounds.

Specifically, for example, as early as between the twenty-first and thirty-third week of gestation the heartbeat of the fetus increases in response to the mother's voice and decreases in response to that of another woman (Kisilevsky *et al.* 2003). Between the thirty-third and forty-first weeks of gestation, the heartbeat of the fetus responds in a distinctive way to the mother tongue and not to other languages, but does not show characteristic response patterns to the voice of the father or that of a woman other than the mother (Kisilevsky *et al.* 2009). At 36 weeks the fetus is able to distinguish whether the mother's voice comes from a loudspeaker resting on her belly or from her actual voice (Hepper, Scott and Shahidullah 1993).

During the first 5 days of life, newborns are more responsive to human voices than to non-linguistic acoustic stimuli (Cheng *et al.* 2012; Ecklund-Flores and Turkewitz 1996; Hutt *et al.* 1968). They are also sensitive to the emotional inflections of prosody regardless of the speaker's gender (Cheng *et al.* 2012). From 12 to 72 hours of age, they open their eyes wider in response to emotionally salient vocalizations emitted by people who speak their mother's language compared to other languages (Mastropieri and Turkewitz 1999). At the same age the speed of perception is greater when listening to vowel sounds of the mother tongue rather than vowel sounds of a foreign language (Moon, Lagercrantz and Kuhl 2010). From one to three days babies are able to distinguish the sound of their own crying from that of other babies (Dondi, Simion and Caltran 1999; Martin and Clarck 1982). From two to four days of life newborns are on average more reactive to the voice of the mother than to that of other women (Querleu *et al.* 1983; Hepper, Scott and Shahidullah 1993; Spence and Freeman 1996; Beauchemin *et al.* 2011) and react differently to the normal voice of the mother and to her motherese (Hepper, Scott and Shahidullah 1993). From two to five days they are also able to segment the sound and distinguish between high and low tones (Winker *et al.* 2003).

Around the eighth month of life, babies begin to lose the ability to perceive non-native phonetic contrasts (Rivera-Gaxiola *et al.* 2005) and to perceive those of their own language better (Polka *et al.* 2001). At nine months they are able to keep the most frequent words in their memory for two weeks (Jusczyk and Hohne 1997). At 11 months, they begin to distinguish words by giving priority to segmental information rather than suprasegmental and contextual information and this will allow them to

recognize a word even if the voice varies in emotional content or if it is pronounced by people of different sexes (Singh *et al.* 2004).
Around 12-14 months children are finally able to make the first semantic-lexical discriminations (Friederici 2005; Dehaene-Lambertz, Dehaene and Hertz-Pannier 2002). This, among other things, improves the ability to phonologically segment words pronounced after those recognized semantically (Bortheld *et al.* 2005). While at 12 months most children still do not systematically look at the right referent of a word, things change at 14 months (Swingley and Aslin 2000). The first words are spoken at 12 months (Zmarich 2010). At around 16 months, the average vocabulary is about fifty words; from 16 to 20 months it expands to about 170 words and from 20 to 24 months it soars, reaching 250-300 words, and the production of initially simple, but gradually more complex sentences begins (De Boysson-Bardies 2010).
Of course, this is not an exhaustive picture either of the development of ocular communication or of the development of language; however, even in this concise formulation, it clearly shows how much more complex and time-consuming the acquisition of linguistic competence is. In comparison, the use of the eyes to convey information appears simpler and more immediate despite the initial disadvantage of the impossibility of beginning its development within the womb. The easier acquisition of the ability to gather information from the eyes and the higher transmission speed of information make eye contact, at first, a vitally important communication tool which, among other things, facilitates the learning of articulated language. As we will see, the importance of ocular communication does not, however, transform it into an indispensable tool either for the development of language, or for the development of a simpler communication skill.

2. Eye contact and language in autism

Autism is a neurodevelopmental disorder that involves deficits in socio-emotional reciprocity and repetitive and stereotyped behaviors (APA 2013). In autism, ocular communication is markedly compromised; it is the first form of communication to show signs of anomalies in autistic symptoms, presenting alterations as early as two months of age. The alteration in the search for eye contact is probably linked to more general anomalies in visual attention: children who receive a diagnosis of autism at 36 months, in fact, at as young an age as 2-6 months tend to look into the eyes of the communicative partner for less time than typically developing children (Jones and Klin 2013). The habit of seeking the other's gaze less will also persist in childhood (Papagiannopoulou *et al.* 2014), adolescence and adulthood (Dalton *et al.* 2005). It has recently been shown that this trend is even present when ocular stimuli are unconsciously perceived (Madipakkam *et al.* 2017).
Other anomalies of visual attention are associated with this trend, such as, for example, the propensity to look at the background area or other details of a social scene for a greater amount of time than subjects with typical development, which, in consequence, leads to the habit of observing salient elements of the social scene such as the hands and faces of speakers for a shorter amount of time (Riby and Handcock *et al.* 2009). Another anomaly of visual attention is the tendency to prefer the vision of non-social rather than social stimuli (Gale *et al.* 2019).
The difficulty in fixing the reference merits a separate discussion: subjects with autism show a marked delay in learning deictic gestures; they use far fewer than subjects with typical development at two and three years of age and there is an absence of certain types of deictics, such as showing something to one's interlocutor with the hands, which is characteristic of autism and are not observed in subjects with developmental delay

(Manwaring *et al.* 2018). They also show deficits and anomalies in the use of others' gaze for reference fixation (Gillespie-Lynch *et al.* 2013) and it is enormously difficult to involve them in triadic interactions with an object because, in addition to following the gaze of others less than typically developed subjects, persons with autism are less responsive to the attention that others show towards the direction of their gaze (Wang *et al.* 2020).

All these anomalies in non-linguistic communication will then find their analogous counterpart in language. About 25-30% of individuals with autism remain non-verbal (Anderson 2007; Norrelgen 2015; Rose 2016; Tager-Flusberg 2013). Almost all the others will acquire language late, indeed, in DSM IV, linguistic delay has been included among the diagnostic criteria (APA 2011). Moreover, the use of deictic gestures in children correlates with the precocity of language acquisition (Ozcaliskan *et al.* 2016). The children with autism who develop language, will have a very distinctive linguistic profile. We cannot describe it in detail here (on the subject see Pennisi 2016), but we will examine some characteristics that – in our opinion – highlight the importance of anomalies in eye contact and the way in which they are subsequently reflected in the linguistic-cognitive structure of the subject with autism.

Let us consider some characteristics of semantics: the first is the difficulty of these subjects in acquiring terms that belong to the semantic fields of emotions and of intentionality. In the Simon Baron-Cohen test mentioned in the introduction, for example, subjects with autism perform significantly less well than the typically developed population (Baron-Cohen *et al.* 2001). In spontaneous narratives, persons with autism make much less use of terms that refer to mental and intentional life (Baixauli *et al.* 2016). In their language, they also tend to neglect the use of deictics, which are frequently not understood and rarely used (Grozdanić 2019; Pennisi 2019).

It seems therefore that the habit we have of talking about emotions, seeking intentionality and fixing the reference (activities in which the eyes typically play a very important role), remain areas of difficulty even for those with autism who develop full language. Could we therefore consider the hypothesis that the added value of eye contact in the development of these communication skills has its own specific and phylogenetically still important peculiarity and that therefore it cannot be completely supplanted by language?

Since autism involves a general deficit of socio-emotional reciprocity, it is possible that these anomalies in the linguistic profile are associated with a more general social competence, rather than with the anomalies in eye contact associated with it. Intrigued therefore by the desire to understand what happens in those who cannot communicate with their eyes but have no specific difficulties in socio-emotional reciprocity, we decided to study these three phenomena (expression of emotion, search for intentionality and fixation of the reference) in subjects affected by congenital blindness.

3. Lexicon of emotions, lexicon of intentions and fixation of the reference in people with congenital blindness

Children with congenital blindness often show a delay in the development of some social skills: they pass the false belief test late (Green *et al.* 2004), they recognize emotions with greater difficulty than typically developing subjects (Dyck *et al.* 2004), show delays in prelinguistic communication and language (James and Stojanovik 2007) and show deficits in pragmatics (Tadić *et al.* 2010), to give just a few examples. Despite this, the acquisition of language seems to fill this gap (Bedny and Saxe 2012), making the adult with congenital blindness an individual without particular social deficits (Arioli *et al.* 2020). In spite of the common linguistic delay, people with congenital blindness from

adolescence already show a greater ability to speak about emotions than sighted subjects of the same verbal age (Dyck *et al.* 2004). They are also able to fully understand the intentions of other speakers (Sak-Wernicka 2015). The deficits in understanding the intentionality of others sometimes found in subjects with congenital blindness correlate with age and verbal intelligence but not with visual abilities (Pijnacker *et al.* 2012; see Greenaway and Dale 2017 for a discussion). The fixation of the reference does not seem to be particularly compromised. It is true that some studies have observed a difficulty in acquiring pronouns, associated with a tendency to frequently invert them (Dunlea 1989; Fraiberg 1977); however, these are somewhat dated studies, never confirmed by strong quantitative data conducted with rigorous scientific methodologies. According to de Vaan *et al.* (2013), the difficulties in the use of deictic terms sometimes encountered are mainly related to the impossibility of evaluating one's position in space with respect to all the other elements and not to deficits in the theory of mind: «there» means «in that position», but for those who visually lack the spatial coordinates it is much more difficult to use this word correctly. Children with congenital blindness use on average the same deictic gestures as their sighted peers (Iverson *et al.* 2000; Iverson and Goldin-Meadow 2001), although they show some differences in performance (e.g. they use the whole palm rather than the index finger for pointing) and use them mainly for objects that are in close proximity (Iverson *et al.* 2000). Therefore, children with congenital blindness do not seem to lack the communicative competence of deixis, but simply the ability to spatially acquire an allocentric perspective because of their sensory deficit. Summing up, children with congenital blindness seem to have a delay in the development of the ability to understand the emotions of others, the ability to understand the intentions of others, and the full use of reference fixation. However, as they grow, they will fully compensate for these deficits.

4. Conclusions

Eye contact is part of a broader body of communication that, in the early stages of life, favors and speeds up the acquisition of language. A child who does not have access to eye contact with other co-specifics will acquire language later than others. The main information conveyed by the eyes are the speaker's emotions, the speaker's intentions and the object of joint attention. Each of these characteristics can also be acquired exclusively through language, in fact, people with congenital blindness can easily develop all of these skills, but the absence of eye contact (and other visual information from others' bodies) slows down their acquisition.

Eye contact is therefore an innate communication tool, easier to acquire than language and so developed with relative ease. Although the ability to gather meaningful information from the gaze of others improves over time, its development is much faster than that of language. Language, however, can compensate for the shortcomings caused by a failure to develop the ability to draw meaningful information from the gaze of others.

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