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## **SOCIAL INTERACTION SHAPES INFANTS' EARLIEST LINKS BETWEEN LANGUAGE AND COGNITION**

The article observes studies of word categorization in 3- to 4-months-old infants questioning their main conclusion that young infants may categorize words themselves. The review shows that there is no bilateral communication between them and adults as well as any perceptual interaction that can help infants acquire language. And yet language acquisition requires children to begin categorizing objects even before they initiate to develop their communication – which happens only from the age of 12 months – since they need to already understand social reality with a minimum set of its phenomena before any communication. Hence, the idea of some mental collaboration between young infants and their caregivers that helps them to acquire a first language makes sense, and these studies show the manifestation of such non-perceptual social interaction. There is every reason to believe that the authors of the analyzed researches excluded any perceptual interaction from experiments that could help infants improve their performance, which also supports this above idea. Their weak results with Cantonese language gives another reason to think so, since English-speaking caregivers (and/or supervisors) could not mentally help infants categorize words during this experiment, as they did not understand Cantonese language.

**Key words:** categorization, first language acquisition, non-perceptual social interaction, coherent intelligence.

### **Sociālā mijiedarbība – agrīno saišu veidotāja starp valodu un izziņu zīdaiņiem**

Rakstā apskatīti un analizēti vārdu kategorizācijas pētījumi 3 līdz 4 mēnešu veciem zīdaiņiem – apšaubot viņu galveno secinājumu, ka tik mazi zīdaiņi vārdus var klasificēt paši. Pētījumu pārskats parāda, ka starp zīdaiņiem un pieaugušajiem nav bilaterālās saziņas, kā arī mijiedarbības, kas varētu palīdzēt zīdaiņiem apgūt valodu. Jebkuras pirmās valodas apguve prasa, lai bērni sāktu kategorizēt objektus pat pirms viņi sāk attīstīt komunikāciju – kas notiek tikai no 12 mēnešu vecuma, – jo viņiem pirms jebkādas komunikācijas jau ir jāsaprot sociālā realitāte ar minimālu tās parādību kopumu. Līdz ar to ideja par mentālo mijiedarbību starp mazu bērnu un viņu aprūpētāju, kas viņiem palīdz apgūt pirmo valodu, varētu apstiprināt neperceptīvas sociālās mijiedarbības ideju. Ir visi iemesli uzskatīt, ka rakstā analizējamo pētījumu eksperimenti, izslēdzot jebkādu perceptīvu mijiedarbību, kas varētu palīdzēt zīdaiņiem uzlabot viņu sniegumu, atspoguļo ideju par neperceptīvu sociālo mijiedarbību, kas notiek neapzinātā līmenī. Viņu rezultāti par kantonas valodu dod vēl vienu apstiprinošu argumentu idejai par mijiedarbību starp cilvēkiem neapzinātā perceptīvā līmenī, jo angļiski runājošie aprūpētāji, kas piedalījās pētījumā, nevarēja mentāli palīdzēt zīdaiņiem klasificēt vārdus šī eksperimenta laikā, jo viņi nesaprata kantonu valodu.

**Atslēgas vārdi:** kategorizācija, pirmās valodas apguve, neperceptuālā sociālā interakcija, koherents intelekts.

### **Социальное взаимодействие как основа формирования связей между языком и познанием у младенцев**

Статья рассматривает исследования категоризации слов у младенцев в возрасте от 3 до 4 месяцев, подвергая сомнению их основной вывод о том, что такие маленькие дети могут сами классифицировать слова. Этот обзор исследований показывает, что между мла-

денцами и взрослыми нет билатеральной коммуникации или какого-либо перцептивного взаимодействия, которые могли бы помочь младенцам овладеть языком. И все же овладение первым языком требует того, чтобы дети начали классифицировать объекты еще до того, как они начинают развивать свою коммуникацию — что происходит только с 12-месячного возраста, — поскольку им уже нужно понимать социальную реальность с минимальным набором ее феноменов ещё до начала любой коммуникации. Следовательно, идея ментального взаимодействия между младенцами и их воспитателями, которое помогает им приобрести первый язык, имеет смысл, и эти исследования показывают проявление такого перцептивного социального взаимодействия. Есть все основания полагать, что авторы проанализированных в данной статье исследований исключили любое перцептивное взаимодействие из экспериментов, которое могло бы помочь младенцам улучшить их результат, что также поддерживает вышеупомянутую идею о перцептивном социальном взаимодействии. Низкие результаты младенцев с кантонским языком дают еще один аргумент в поддержку этой идеи, поскольку англоговорящие воспитатели (и/или руководители эксперимента) не могли мысленно помочь младенцам классифицировать слова во время этого эксперимента, поскольку они сами не понимали кантонский язык.

**Ключевые слова:** категоризация, усвоение первого языка, перцептивное социальное взаимодействие, когерентный интеллект.

## Introduction

It has already become convincingly that the first language acquisition can be explained as a set of successive and at the same time parallel mental process, in very easy words: “successful word-learning rests on the infant’s ability to discover the relevant linguistic units, the relevant conceptual units, and the mappings between them” (Waxman, Leddon 2010, p. 6). Starting their socialization, infants are required to constitute their conceptual domain of knowledge, forming core concepts to capture the various relations among the objects and events that they encounter, and from the other hand the broad linguistic domain of the current flow of language requires infants select words and phrases from them to apply each element to different grammatical categories for then remember words and adequately respond. Herewith, their advances in the conceptual and linguistic domains are fast and powerfully linked, that looks like too complicate problem for such inexperienced and young students. That is, first language learning requires a certain degree of abstraction in each of these above noted domains. Any given utterance of a word must be related to an abstract phonological representation, any given individual must be related to an abstract concept (Bates, Goodman 1997; Chomsky 1975), and all these mental actions arise in a short period at the very beginning of personal mental development.

Grammatical categories provide language users with an efficient and powerful means of representing regularities in linguistic structures and processes. Grammatical categories – withall difficulties of understanding the difference of application its components in real discourse – are the building blocks that structure human languages and the units over which syntactic and morphological processes operate. That is why over the past 30 years, the mechanism of categorization in word learning has become one of the main object of investigation in cognitive science on first language acquisition.

The two basic approaches – innate syntactic knowledge opposed to another view based on experience – attempt to explain categorization. “On one influential view, at least some aspects of syntax must be innate, since the child possesses syntactic knowledge that could not have been learned from his or her impoverished linguistic input” (Chomsky 1981; Pinker 1989; cited by Regier, Gahl 2004, p.147). The critics of this approach point weak arguments of the hypothesis of innate syntactic knowledge. Essentially, this synthetic statement can neither be proved nor disproved empirically. G. Sampson argues that the grammatical “rules” linguists posit are simply post-hoc observations about existing languages, rather than predictions about what is possible in a language (Sampson 2005). W. Hinzen summarizes the most common criticisms of universal grammar: 1) universal grammar has no coherent formulation and is indeed unnecessary; 2) universal grammar is in conflict with biology: it cannot have evolved by standardly accepted neo-Darwinian evolutionary principles; 3) there are no linguistic universals: universal grammar is refuted by abundant variation at all levels of linguistic organization, which lies at the heart of human faculty of language (Hinzen 2012). The core idea of the opposite approach is linguistic empiricism, which supports that children do not have linguistically-specific knowledge at birth, all ideas are derived from experience. Within this perspective, for example M. Ramscar and D. Yarlett propose a learning mechanism of unreasonable expectations, when infants erroneously expect any linguistic construction which is ungrammatical form that then never occurs, then this repeated unreasonable waiting becomes a form of implicit negative feedback (Ramscar, Yarlett 2007). Such experiences allow children to learn language, by correcting their errors over time. The weakness of this approach – first language acquisition is too difficult problem to infants, taking into account the following difficulties: lack of skills, communication, experience and knowledge – has become the argument for the idea of universal grammar in decades of opposition of these approaches. This broad discussion on the issue – with convincing arguments and a wide range of well-constructed hypothesis supported by numerous empirical studies – allow to assume that many of these ideas reflect (to a greater or lesser extent) the phenomenon and together contribute cumulatively to the understanding of how infants learn the first language. That is, highly likely, that some genetic mechanism promotes creation of a mental frame of language acquisition of newborns, which then helps infants to understand and learn words (Chomsky 1981); convincingly that, early in life, language promotes categorization in part through its status as a social, communicative signal, and that distributional patterns of words impact on categorization (Ferguson, Waxman 2017); obviously that the intensity of social interaction contributes to word learning, that there is a relation between cognitive and social skills with linguistic competence (Sampson, 2005; Tomasello 2008); it is also very likely that many other existing ideas also offer compelling theories with empirical evidence, complementing the complex mechanism of first language learning. Acquisition of knowledge mainly based on discovery of new key relationships between cause and effect within prior knowledge, and/or on the opening links between elements of prior knowledge and new information domain. This means that the acquisition of initial words also requires infants to demonstrate some basic knowledge on the social reality around – specific basic knowledge

of their particular group, considering the existence of about 6,000 languages in even more groups and communities, all with their unique social reality – as well as needs efficient communication which is a reciprocal exchange of mutually intended meanings. Even if one assumes that one of existing hypotheses or all together correspond to mechanism of word learning, if one also ignores the effectiveness of communicative needs that must maintain this mechanism (always keeping in mind the very young ages of students), the question of acquiring the meanings of the initial phenomena – the very first objects and events in the life of infants – the same meanings that already exist in their group remains unclear. That is, relating with what newborns' knowledge and/or with what kind of communication young infants can understand first meanings of phenomena of the surrounding social reality – the meanings of objects and events – in order to then create the appropriate conceptual units that connect them with the corresponding linguistic units (words). This is not a question of the language structure and grammatical categories – which also need to be accompanied with efficient communication with community to be accepted adequately – this is a problem of a comprehension of particular social reality. The above-mentioned approaches may explain the process of establishing a mapping between the conceptual and linguistic units, but cannot provide a convincing picture of how unclear and multivalued social interaction between very young infants and their social group can give them a set of meaningful impulses that begin word learning. What kind of prior knowledge or known communication or what else can help newborns begin and facilitate learning until they understand the meanings of enough words to begin categorization, to then understand phrases and complete their own questions?

Recent studies on language acquisition attempt to address this problem by suggesting that infants exhibit some general sensitivities and expectations at the onset of language acquisition that later become adjusted to the particular language environment that the young infants finds around. For instance, S. Waxman and E. Leddon have proposed that: 1) infants begin the task of word learning equipped with an initially general and universal expectation; 2) expectation is then formed by the structure of the particular language (Booth, Waxman 2003; Fulkerson, Waxman 2007; Klibanoff, Waxman 2000; Waxman 1998; Waxman, Booth 2000a; Waxman, Booth 2001b; Waxman, Markow 1995; cited by Waxman, Leddon 2010); and then 3) infants growing sensitivity to these perceptual cues permit them to separate two classes of words: open class words (nouns, adjectives, verbs) and closed class words, including determiners and prepositions. (Waxman, Leddon 2010)

According to G. Csibra and G. Gergely infants are sensitive to certain ostensive cues. Their theory of natural pedagogy suggests that infants expect to learn reference information through signals that relatives direct to them. In the case of young infants these ostensive cues for example manifest themselves in following the gaze (Csibra, Gergely 2009).

### **Social interaction of infants**

May some general sensitivities and expectations as well as ostensive cues complement the children picture of reality in such a manner that 3- to 4-months-old infants understand enough phenomena from social reality to start categorization of words? The article discusses this issue to show that communication is a difficult problem for 3- to 4-months-old infants, they cannot successfully form categories of words on their own. The perceptual sensitivities and expectations (Waxman, Leddon 2010), and/or ostensive cues (Csibra, Gergely 2009) are not able alone to fill infants' personal reality with a sufficient number of phenomena in order to start categorization.

Social interaction constructs social reality, engaging a wide range of mental tasks of participants through various conscious and unconscious manifestations, which can be meaningful or meaningless. There are four possible domains of perceptual social interaction: 1) conscious meaningless interaction – conscious priming-sensitivity exchange; 2) unconscious meaningless interaction – unconscious priming-sensitivity exchange; 3) conscious meaningful interaction – conscious verbal and nonverbal communication; and 4) unconscious meaningful interaction – unconscious verbal and nonverbal communication. Communication is a complicated process of mutual exchange of meaningful signs with a goal-setting within the framework of participants needs and understanding of social reality. M. Argyle, V. Salter, H. Nicholson, M. Williams and P. Burgess argued that the primary function of nonverbal communication is to develop and strengthen interpersonal relationships, while verbal communication is used to convey the meaning of events (Argyle et al. 1970). It is important to note that emotional contagion, and behavioral assessment are only additional tools for any communication, that they together require some mutual exchange between infants and adults before them because: 1) the adoption of emotions of others means the same estimation of emotional states by both sides of this exchange, which is subject to prior agreement, and 2) principles and categories of behavioral assessment must also be convincingly taken before – for example, “true or false”, “good or bad”, etc. – with the purpose to correlate them with the actual condition. That is, any communication between 3- to 4-months-old infants and adults can occur within the framework of some prior mental cooperation between them. Non-verbal communication is an accompaniment of mutual exchange of meanings, helping participants to facilitate filling of all phenomena of reality with mutual meanings. But their impact is not so fruitful and lasting that 3- to 4-months-old infants can understand the meanings of symbols, for example, through tone of voice and/or body language, to then adopt necessary social skills, such as language. Newborn infants are faced with an unknown social reality, communication for them is a difficult problem as they do not understand enough surrounding social phenomena, and at the beginning of life, their social interactions are meaningless. While they collect and understand the phenomena of social reality, their expressions of basic instincts are also meaningless gestures. In the first months of life, they cannot even adequately move their body, they still need to learn how to express themselves. Infants' meaningless expression – priming-sensitivity exchange of stimuli with adults – is not yet communication, it does not operate signs

with reciprocal intended meanings. The meaningless interaction eventually transforms into communication later, when the participants in this exchange imbue interaction with mutually intended meanings, cascading their signals in response to the history of past meaningless interactions and in response to the history of social relationships between infants and the social reality surrounding them. That is, both conscious priming-sensitive exchange and unconscious priming-sensitive exchange can only be a preparation for communication, as well as the accompaniment of future communication on the basis of mutual signs, which will subsequently be created by the above-mentioned process of preparation. Pre-communication perceptual exchange manifests itself as newborns begin to interact and create their shared social reality with adults, but of all the known domains of perceptual social interaction, only communication can fill the phenomena of reality of meanings.

The article emphasizes that at the age of infants 3- to 4-months between them and adults there is no any communication at all. Non-verbal communication occurs only from 12 months, which can be assumed based on the facts: 1) “communicative pointing acts induce object expectations at 12 months of age, but not at 8 months of age, and that these expectations are specific to a referentialcommunicative as opposed to an attentiondirecting nonsocial cue” (Patzold, Liszkowski 2019); 2) non-verbal communication and decoding skills improve between the ages of 12 months and 8 years. K. Liebal, M. Carpenter and M. Tomasello have shown the ability to recognize markedness (gesture during speech) is learned in the early stages of development, somewhere between three and four years of age, but two-years-olds’ appreciation of these gestures was less clear-cut (Liebal et al. 2011); 3) R. Boone and J. Cunningham argued that 4-year-olds (not younger) could only correctly identify sadness at a rate that was better than random, by studying at what age children begin to recognize emotional meaning (anger, fear, happiness, and sadness) in expressive body movements (Boone, Cunningham 1998); 4) the absence of communicative signals, ostensive cues also cannot effectively convey the meanings of phenomena because of their polysemic manifestations: “6-months-old infants follow others’ gaze direction in situations that are highly attention-grabbing. This occurs irrespective of whether these situations include communicative intent and ostensive cues (a model looks directly into the child’s eyes prior to shifting gaze to an object) or not (a model shivers while looking down prior to shifting gaze to an object). Findings demonstrate that one of the central pillars of natural pedagogy is false. Sensitivity to gaze following in infancy is not restricted to contexts in which ostensive cues are conveyed” (Szufnarowska et al. 2014). In summary, all these facts taken together may mean that only from the age of 12 months, can social interaction with infants be transformed into communication after the previous cascading their signals in response to the history of past meaningless interactions and in response to the history of social relationships the surrounding social reality.

Certainly, young infants should begin language categorization even before they initiate to develop their communication – which occurs only from the age of 12 months – since they need to already understand social reality with a minimum set of its phenomena before any communication. Thus, some mental collaboration between young

infants and their social environment should accompany the mental development of infants, helping them to acquire the meanings of the initial phenomena of social reality. But the essence of this process is still in question due to the lack of perceptual interaction of infants with the surrounding reality.

### **The reinterpretation of results of two studies on categorization in 3- to 4-months-old infants**

A. Ferry, S. Hespos and S. Waxman as well as D. Perszyk and S. Waxman conducted the series of experiments on categorization of words in 3- to 4-months-old infants (Ferry et al. 2010; Perszyk, Waxman 2019). But, as can be seen from the above reflections, young infants could not perceptually interact with their social group so effectively that at the age of 3–4 months, their personal reality may contain enough phenomena to successfully form categories of words on their own. Thus, the critical question to the studies is what helped these infants in their performances. It is necessary to note several circumstances to assess their results:

- infants participated at the experiments always with adults: with their caregivers in pair, infants sat on a caregivers' lap facing the stage as well as a supervisor of the experiment, who was there in the contact with infants;
- infants did not perceptually interact with anyone during experiments;
- all persons involved in the experiment – both participants of the pairs infant-caregiver as well as the supervisor – received tasks simultaneously;
- infants improved performance during the experiments when objects were marked vocally that present adult also listened to;
- the chosen visual stimuli are fishes and dinosaurs from different classes, that do not fit into the personal reality of 3- to 4-months-old infants.

Both the adults' involvement in the procedure of the studies of A. Ferry, S. Hespos and S. Waxman as well as D. Perszyk and S. Waxman and the impact of caregivers and supervisors on the performance are not very clear from the publications as well as the isolation of infants from their influence is not obvious (Ferry et al. 2010; Perszyk, Waxman 2019). During the experiments of A. Ferry, S. Hespos and S. Waxman, the caregivers could know both visual and auditory stimuli: "infants sat on a parent's lap. Parents were instructed not to influence their infant's attention in any way and to close their eyes during test trials" (Ferry et al. 2010). The second study tried to minimize the impact of caregivers on the performance: "infants were seated on a caregiver's lap facing a screen. Caregivers, who wore opaque glasses, were instructed not to talk to their infants or influence their attention in any way" (Perszyk, Waxman 2019). There are several disputable points that need to be clear to understand of what helped these infants in their performance. How the experimenters managed the procedure and supported the infants as they sat on the lap of the "blinded" parent – was there someone else, a supervisor, in the room at that moment, whether this supervisor perceived the stimuli. As also whether the caregivers knew about the stimuli and procedure before the experiment. Even if one assumes that the caregivers were not



informed of the tasks and procedure before the experiment and they were “blinded”, they could still listen to the auditory stimuli throughout the experiment and mentally follow its procedure. Even if one assumes that the supervisor of the experiment did not stay together with testees in the same room, he or she knew the procedure and stimuli, as well as highly likely that the supervisor was connected emotionally with infants before the experiment and followed the procedure mentally together with testees. That is, there was always someone with infants, who knew the procedure and stimuli and was interested in the performance.

Anyway, both studies emphasized successfully formation of object categories by infants, while their perceptual assimilation of phenomena as well as a reception of any perceptual help from their caregivers (or supervisor) were impossible. Due to the above mentioned reflections, the increase in infants’ performance may mean either some prior innate knowledge of objective reality or – following the above considerations and mainly the fact that there was always someone with infants during the experiments, who knew the procedure and stimuli – some non-perceptual social interaction between infant-adult pairs which should also be considered.

The last idea is supported by another finding of D. Perszyk and S. Waxman from their experiment with Cantonese language, which is an East Asian language with 62 million (2013) native speakers mainly from Southern China, Hong Kong, Macau, Malaysia and Singapore (Perszyk, Waxman 2019). D. Perszyk and S. Waxman argued that their study provides “evidence that infants’ increasing precision in speech perception shapes which signals they will link to cognition. Infants listening to German, a nonnative language that shares key rhythmic and prosodic properties with their own native language (English), successfully formed object categories. In contrast, those listening to Cantonese, a language that differs considerably in these suprasegmental properties, failed” (Perszyk, Waxman 2019). There is no information about the language these caregivers/supervisor speak, but obviously they had to speak English – and highly likely, they understood simple phrases in German as well – as they were the caregivers of English speaking infants and the supervisor was someone from the Northwestern University, Evanston, USA. There is a correlation between adults’ main language and the infants’ performance. That is, the contribution of non-perceptual interaction to the mental collaboration between pairs infant-adult may seem more probabilistic than infants’ prior innate knowledge. From this perspective results of A. Ferry, S. Hespos and S. Waxman as well as D. Perszyk and S. Waxman may also mean an evidence of a mental collaboration within – pairs infants and their caregivers (Ferry et al. 2010; Perszyk, Waxman 2019). The weak results of their experiment with Cantonese also supports this idea that may also mean that English-speaking caregivers/supervisor could not help infants categorize words during this experiment, as they did not understand Cantonese language, which also supports the hypothesis of non-perceptual interaction.

Another argument that supports above reinterpretation of the results of A. Ferry, S. Hespos and S. Waxman as well as D. Perszyk and S. Waxman based on the chosen visual stimuli. Two 8-item familiarization sets and two test pairs were the images of dinosaurs and fish. Infants saw images from one object category (dinosaurs) during a



series of “familiarization” tasks. They then simultaneously viewed two new “test” images from the familiarization category (another dinosaur; “familiar object”) and a new exemplar from a novel category (a fish; “novel object”). The current article believes that the images for such a task has to be phenomena from infants’ personal reality. Dinosaurs from different classes and fishes are probably not the right objects for the experiment of categorization with very young infants. It is very difficult to believe that they can themselves categorize such phenomena. Whether 3- to 4-months-old infants know enough about nature and its evolution to categorize objects that are absent or inaccessible to their reality.

Recent experiments show an improvement of the group’s performance that can be explained as unconscious mental collaboration through non-perceptual interaction. This series of studies was conducted at the Riga Stradins University in Latvia. The within-subject design with a multiple-choice test – which required participants to simultaneously guess the English translation of Latin paraphrases – adhered to two research paradigms: 1) the two-step experiment with the primed/unprimed conditions for confederates with the same questionnaire for all in the both steps, that confederates and unprimed participants had to take the same questionnaire twice as a repetition task; 2) the experiment with the unprimed condition in the baseline and primed condition in experimental testing, that primed confederates and unprimed participants had to complete the questionnaire as one task. In particular, experiments in each paradigm examined how accurately the group of unprimed participants could classify Latin phrases, comparing their performance under two conditions for confederates: unprimed or primed with hints regarding the correct answer.

The study under the paradigm 1 conducted three experiments with forty six adults (mean age  $M=18$  years). Forty students speak Latvian and six Russian, they also speak English and have not studied or spoken Latin language. Participants and confederates with Android-based tablet computers sat at their tables face to face at a distance of more than three meters between their seats in the auditorium, so they saw each other’s faces. The Latin paraphrases with options from the questionnaire appeared for all examinees on their tablet computers at the same time, participants and confederates were not able to see the content/display of the others tablet or the answers that other member of the group enters. These devices presented one after another simultaneously 10 Latin paraphrases of 30 seconds each with the same 10 variants of English translation, all questions and answers were the same for all examinees. Any communication between participants and confederates during experiment was excluded. The experiments consisted of two steps with the same task in each: the first session was held without assistance for both confederates and participants, and, during the second session, confederates were primed with hints regarding the correct answer on each Latin paraphrase. The confederates were asked to follow the tips on correct answers. All volunteers did not know before the experiments about the second step with the repeated task. The correct answers were calculated only for the unprimed participants. The ratio of  $R(1) = 1.68$  was presented, that is, an increase of performance was 21 percentage points. The result of the study 1 is 5.7 times higher than random choice (the score  $S(1|2) = 0.57$ , and the probability  $P(1|2) = 0.1$ ). The study under the

paradigm 2 conducted the experiment with eleven adults (mean age  $M = 18$  years). The native language of students is Russian, some of them also speak English and all of them have not studied or spoken Latin language. The volunteers performed the experiment in one group with five confederates and six participants. This experiment was conducted with the same procedure as the previous ones with several changes: 1) the experiment consisted of one list of 20 Latin paraphrases and their 10 answer choices for each phrase: the baseline questionnaire with 10 Latin paraphrases, and the experimental testing questionnaire with another 10 Latin paraphrases; 2) the baseline questionnaire and experimental testing questionnaire proceeded without any pauses, during the experimental testing confederates were primed with hints regarding the correct answer to each Latin paraphrase. All volunteers did not know when someone and who will be assisted in answering questions. The correct answers were calculated only for the unprimed participants. The ratio of  $R(2) = 1.56$  was presented, that is, the productivity gain was 9 percentage points. The result of study 2 is 2.5 times higher than random choice (the score  $S(2|2) = 0.25$ , and the probability  $P(2|2) = 0.1$ ).

These studies examined the ratio of correct answers between primed and unprimed conditions, whether it is possible, that confident knowledge of the correct answers of primed confederates can allow unprimed participants to find the correct answer to the problem of an unknown language. The research shows a significant increase of performance of the unprimed participants (the ratio of correct answers  $R(1) = 1.68$  and  $R(2) = 1.56$ ) between primed and unprimed conditions of confederates, showing empirical evidence for the effect of non-perceptual social interaction on group outcome, which occurs without verbal and non-verbal communication and does not engage five basic human senses. I. Val. Danilov, S. Mihailova, and V. Perepjolkina presented their research at the 12th annual International Conference of Education, Research and Innovation Seville (Spain) on 11th–13th of November, 2019. The study shows the effect of the group performance which is weak for communication, but significant for outcome of non-perceptual mental collaboration. I. Val. Danilov believes that non-perceptual social interaction is so slight and implicit that it does not allow consciousness to recognize it as a transmission of information (Danilov 2019). This mental collaboration is less effective than communication, comparing their possible outcomes. The advantage of non-perceptual social interaction is that it can accompany the mental development of infants, helping them to acquire meanings of the initial phenomena of social reality. In such a manner, this mental collaboration may contribute to the first language acquisition in the absence of communication. Non-perceptual social interaction may be a possible explanation for how infants may understand social reality with a minimum set of its phenomena before any communication at the beginning of their lives. This idea underscores how important it is for very young infants to have a strong emotional connection with caregivers.

One possible explanation for non-perceptual social interaction, based on the existing laws of physics, was introduced by I. Val. Danilov: “Coherent Intelligence is an effect of unconscious collaboration provided by interconnection of many brains united by entanglement state of their neurons – the phenomenon of quantum entanglement of particles – which is stimulated by common emotional arousal. This connection

of entangled neurons may unite neural chains of different cerebrums and maintain their coherent mental process” (Danilov 2019, p. 109). I. Val. Danilov supposes that the phenomenon emerges from collective efforts and collaboration of many individuals if: 1) participants experience the same emotional arousal; 2) they simultaneously solve the problem, which is important for them, within the framework of this emotional stimulation (Danilov 2019).

## Conclusions

The article observes studies of words categorization in 3- to 4-months-old infants – the two studies of A. Ferry, S. Hespos and S. Waxman (2010) as well as D. Perszyk and S. Waxman (2019) on – questioning their main conclusion that young infants may categorize words themselves. Obviously, that young infants have to begin language categorization even before they initiate to develop their non-verbal communication, which only occurs since 12 months of age, because they need to already understand social reality with a minimum set of its phenomena before any communication. The current study assumes some mental collaboration between infants and their caregivers that helps young infants to acquire first language and the manifestation of which occurs in these experiments with young infants. Non-perceptual social interaction between pairs infants and caregivers (or supervisors) may be the possible explanation of their performance, due to the fact that experimenters excluded any perceptual interaction with infants that could help them improve their performance. The main arguments of this reinterpretation are:

- 1) there is no doubt about the relevance of the chosen method and the correctness of the procedure of these studies; but it is incredible that 3- to 4-months-old infants can perceptually interact with their corresponding group so effectively that their personal reality may contain enough phenomena to begin successfully acquiring first words in their lives to then forming categories of words on their own;
- 2) very young infants cannot themselves recognize and classify inappropriate phenomena that are absent or inaccessible to their reality; even if one forgets about the problem of assimilating of first notions and the acquiring of the first words, and supposes that infants somehow themselves have already learned some basic set of meanings, there is another problem of comprehension of abstract phenomena – the above-noted fishes and dinosaurs are not suitable objects for the categorization experiment with 3- to 4-months-old infants; it is very hard to believe that without the help of adults they can categorize such abstract phenomena;
- 3) during the experiments on categorization of words there was always a pair infant-caregiver as well as the supervisor of the experiment; that is, there was always someone, who knew the procedure and stimuli and could interact with infants;
- 4) there is a correlation between adults' main language and the infants' performance; this last argument, combined of previous ones, also supports some non-perceptual interaction in the collaboration within pairs infant-adult and thus the idea of the contribution of non-perceptual interaction to mental development of infants may seem convincingly.

The recent research on non-perceptual social interaction and its impact on group performance gives possible explanations of this notion basing on the existing laws of physics (Danilov 2019).

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### References

- Argyle M., Salter V., Nicholson H., Williams M., Burgess P. (1970) The communication of inferior and superior attitudes by verbal and non-verbal signals. *British Journal of Social & Clinical Psychology*, Vol. 9, No. 3, pp. 222–231. doi.org/10.1111/j.2044-8260.1970.tb00668.x
- Bates E., Goodman J. (1997) On the inseparability of grammar and the lexicon: evidence from acquisition, aphasia and real-time processing. *Language and Cognitive Processes*, Vol. 12, No. 5/6, pp. 507–584. doi.org/10.1080/016909697386628
- Boone R., Cunningham J. (1998) Children's decoding of emotion in expressive body movement: The development of cue attainment. *Developmental Psychology*, Vol. 34, No. 5, pp. 1007–1016. doi.org/10.1037/0012-1649.34.5.1007
- Chomsky N. (1975) *Reflections on Language*. New York: Pantheon.
- Chomsky N. (1981) *Lectures on Government and Binding*. Dordrecht: Foris.
- Csibra G., Gergely G. (2009) Natural pedagogy. *Trends in Cognitive Sciences*, Vol. 13, Issue 4, pp. 148–153. doi.org/10.1016/j.tics.2009.01.005
- Danilov I. Val. (2019) *Unconscious Social Interaction: Coherent Intelligence. Second edition complemented*. E-book. Available: <https://www.amazon.com> (accessed on 28.12.2019).
- Ferguson B., Waxman S. (2017) Linking language and categorization in infancy. *Journal of Child Language*, Vol. 44, Issue 3, pp. 527–552. doi.org/10.1017/S0305000916000568
- Ferry A., Hespos S., Waxman S. (2010) Categorization in 3- and 4-months-old infants: an advantage of words over tones. *Society for Research in Child Development*, Vol. 81, Issue 2, pp. 472–479. doi.org/10.1111/j.1467-8624.2009.01408.x
- Hinzen W. (2012) The philosophical significance of universal grammar. *Language Sciences*, Vol. 34, Issue 5, pp. 635–649. doi.org/10.1016/j.langsci.2012.03.005
- Liebal K., Carpenter M., Tomasello M. (2011) Young children's understanding of markedness in non-verbal communication. *Journal of Child Language*, Vol. 38, No. 4, pp. 888–903. doi.org/10.1017/S0305000910000383
- Patzold W., Liszkowski U. (2019) Pupillometry reveals communication-induced object expectations in 12- but not 8-months-old infants. *Developmental Science*, Vol. 22, Issue 6, e12832. doi.org/10.1111/desc.12832
- Perszyk D., Waxman S. (2019) Infants' advances in speech perception shape their earliest links between language and cognition. *Scientific Reports*, Article Number 3293. doi.org/10.1038/s41598-019-39511-9
- Pinker S. (1989) *Learnability and Cognition: The Acquisition of Argument Structure*. Cambridge, MA: MIT Press.

- Ramscar M., Yarlett D. (2007) Linguistic self-correction in the absence of feedback: a new approach to the logical problem of language acquisition. *Cognitive Science*, Vol. 31, No. 6, pp. 927–960. doi.org/10.1080/03640210701703576
- Regier T., Gahl S. (2004) Learning the unlearnable: the role of missing evidence. *Cognition*, Vol. 93, No. 2, pp. 147–155. doi.org/10.1016/j.cognition.2003.12.003
- Sampson G. (2005) *The 'Language Instinct' Debate: Revised Edition*. Bloomsbury Academic.
- Szufnarowska J., Rohlfing K., Fawcett C., Gredeback G. (2014) Is ostension any more than attention? *Scientific Reports*, Vol. 4, Article Number 5304. doi.org/10.1038/srep05304
- Tomasello M. (2008) *Origins of Human Communication*. Cambridge, MA: MIT Press.
- Waxman S., Leddon E. (2010) *Early Word-Learning and Conceptual Development*. *The Wiley-Blackwell Handbook of Childhood Cognitive Development*. Available: [https://www.academia.edu/12821552/Early\\_Word-Learning\\_and\\_Conceptual\\_Development](https://www.academia.edu/12821552/Early_Word-Learning_and_Conceptual_Development) (accessed on 28.12.2019).