Creating A Shared Representational Space

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Abstract

The mechanisms that make the unique sociality of humans possible have long been in the focus of cognitive science. In this paper, we review recent advancements in the study of three fundamental social cognitive functions (social categorization, theory of mind and social learning) in order to outline a theory that emphasizes the need to consider their interconnectedness. We propose that the ability to represent the social world along categories and the capacity to read others' minds are used in an integrated way to efficiently assess the epistemic states of fellow humans by creating a shared representational space. We propose that the emergence of this shared representational space is both the result of and a prerequisite to efficiently learn about the physical and social environment.

Keywords: social learning, social categorization, theory of mind, shared representational space, shared knowledge

One of the most prominent features of our species is its unique sociality (Richerson & Boyd, 1998). Humans can communicate and coordinate their behavior with others with remarkable ease and efficiency, laying the ground for smooth interactions and a wide range of possibilities for cooperation both at the dyadic and the group level (Henrich, 2004). Research in psychological science has identified a number of key cognitive functions necessary for the success of social interactions in humans, such as our ability to reason about the mental states of others; communication; social learning; social categorization; etc. Moreover, studies on animal cognition suggest that each of these capacities entail at least some characteristics that are uniquely human (e.g. Call & Tomasello, 2008; Csibra & Gergely, 2011) and researchers have argued that our highly developed social-cognitive abilities have been fundamental for the evolution of other higher-order cognitive skills as well (Hermann, Hernández-Lloreda, Hare & Tomasello, 2007). However, intense dispute surrounds the question of which of these social-cognitive functions have set our species on this unique evolutionary pathway. While some argue that it can ultimately be traced back to our motivation to pass on information (Gergely & Csibra, 2005), others identify the need and ability to share psychological states with others as the focal point (Tomasello, Carpenter, Call & Behne, 2005). Without attempting to resolve this debate, in this paper we draw attention to the fact that to account for human intelligence, we should not simply focus on the overdeveloped nature of a single isolated cognitive function, but rather on the unique way these processes come into interaction with each other.

A few attempts have already been made to describe the interconnectedness of some of these capacities. Theories have emphasized, for example, the crucial role of intention reading in communication (Grice, 1957; Sperber & Wilson, 1986) or that of communication in human social learning (Csibra & Gergely, 2006). Lately, growing interest surrounds the question of

how social categorization is used for mental state attribution (Spaulding, 2017; Westra, 2017).

Our paper outlines a theory on how theory of mind, social categorization and social learning intertwine. We emphasize a specific function of social categorization – providing a shortcut to assess the epistemic state of another individual - that makes category information especially relevant for mindreading. Additionally, we will argue that basic social learning mechanisms contribute to the formation of social category representations which are then used for mental state attribution. Specifically, we propose that young children may start differentiating between social groups or categories in their effort to maximize their culturally valid knowledge about their social and physical environment. We argue that children draw on cues of shared cultural knowledge to map out social relations, which information helps them to learn from the most relevant teachers and may also feed into mentalization processes.

Note, however, that the type of social distinctions we discuss here are not exhaustive. We do not make assertions to biologically relevant social categories (e.g. sex) and no doubt, older children and adults derive social categories (and make inferences) from almost an endless number of factors. In this paper, we do not make assumptions about one particular distinction (such as nationality, for example) but to any differentiation where a group can be characterized with a body of shared knowledge. We argue that such distinctions make it possible to flexibly and dynamically adjust our behavior and communication in social interactions.

Social categorization on the basis of shared knowledge

It has long been noted that the human mind exhibits extraordinary sensitivity to detect the borders of social groups or categories (e.g. Allport, 1950; Tajfel, Billig, Bundy &

Flament, 1971). While adults tend to use any – even arbitrary - category-distinctions to guide social behavior (Tajfel et. al., 1971), some markers seem to be more fundamental than others, such as sex and age (Fiske, 2000); coalitional relations (Kurzban, Tooby & Cosmides, 2001); kinship (Lieberman, Oum & Kurzban, 2008) or language (Pietraszewski & Schwarz, 2014). An important question concerns the mechanisms through which these category representations develop. Based on the observed priorities in social categorization, a number of theories have offered “candidate” cues that the human mind may be specifically adapted to attend to in order to start parsing the social environment in a meaningful way and create representations of social categories. For example, Kurzban and colleagues (2001) have suggested that cues of coalitional relations may be especially relevant in making inferences about the structure of the social world, while Rhodes and Chalik (2013) suggested that social categories are viewed as markers of social obligations. Liberman and colleagues (2017) have proposed that humans are especially attuned to linguistic cues to make inferences about social partners. This idea is supported by ample evidence from research in developmental psychology, showing that from early on, children strongly prioritize linguistic cues (spoken language or accent) over other markers of social categories. It has also been shown that young children are more willing to learn from or follow the behavior of someone who speaks their native language (e.g. Buttellmann, Zmyj, Daum & Carpenter, 2013; Howard, Henderson, Carrazza & Woodward, 2015; Oláh, Elekes, Pető, Peres & Király, 2016; Pető, Elekes, Oláh & Király, 2018).

In this paper, we suggest a different candidate signal along with a proposed mechanism through which category representations may be formed. Our proposition is that the effectiveness of linguistic cues in guiding social categorization comes from the fact that language is a direct signal of a core property of human social groups: shared knowledge. In contrast to animal groups, human group cohesion is arguably most fundamentally set by the

shared norms and knowledge of group members (e.g. Romney, 1999). Therefore, social categorization as an adaptive mechanism would be guided by cues that provide information about the very nature of these distinctions. Linguistic cues are appropriate markers of shared knowledge as although language is a universal human capacity, it shows significant variations between groups while tends to be stable within groups. If language gains its inferential power for being part of the category defining shared knowledge itself, language should not be the *only* marker that humans can use to the same effect. A handful of studies have pointed out that other aspects of shared knowledge show similar effects in guiding social preferences or inferences. For example, Oláh and Király (2019) have shown that children are more willing to copy the behavior of someone who has used tools in a conventional way than someone who consistently violated social norms regarding tool-use. Moreover, having similar knowledge about music also efficiently drives social preferences (Soley & Spelke, 2016). Importantly, there is evidence that children draw connections between different aspects of shared knowledge: children already at 2 years of age expect people speaking the same language to share knowledge in other domains as well (Oláh, Elekes, Bródy & Király, 2014; Soley & Aldan, 2018).

Representing social categories based on shared knowledge also explains the dynamic nature of this representational system – that is, that the category distinction we use to describe a person can change rapidly and can vary in taxonomical rank. Relatedly, humans seem to readily accept multiple social categorization (Crisp & Hewstone, 2007), that is, the fact that a person belongs to many different social categories at the same time.

Widespread theories in social psychology that emphasize that social category representations serve to map the affiliative relations between individuals would not require such flexibility in this process. In fact, constant switching between group identifications would make it difficult to either base our self-worth on group membership (Tajfel et al.,

1971; Turner, Hogg, Oakes, Reicher & Wetherell, 1987), define who is our competition over resources (Sherif, Harvey, White, Hood & Sherif, 1961), place ourselves in a stable hierarchy of social groups (Sidanius & Pratto, 1993) or even to identify coalitional partners (Kurzban et al., 2001). However, if one of the most fundamental inferences one can make based on social group membership is about the type of group-specific (cultural) knowledge someone is in possession of, this dynamicity becomes very adaptive. This makes us realize in an instant that when we talk to a colleague we have to use different jargon than when we are among family members or that when we meet someone from a different country we not only have to speak in a different language but also cannot make short references to local things without further clarification. What is more, this system would also allow the flexibility to rapidly adjust our communication within the very same interaction based on topic: for example, when during a discussion with co-workers we switch to non-work related topics, we will likely limit our expectations of shared knowledge and start giving more information for the sake of clarity.

The development of social category representations based on shared knowledge

How do children start parsing their social environment into meaningful units? As described earlier, social categorization serves as an important input for social learning in that it helps the novice to efficiently organize incoming information based on cultural relevance (e.g. Buttelmann et al., 2013). However, we suggest a bidirectional relationship between the two mechanisms in which human-specific learning processes also lay the ground for the differentiation of social categories.

The natural pedagogy theory put forth by Csibra and Gergely (2009) claims that information presented in a communicative context is more likely to be encoded as both generic (valid in other contexts) and universal (shared with others). Thus, due to the

pedagogical context of everyday knowledge acquisition, a large body of children's knowledge includes the assumption that other people are going to share it. This notion is supported by empirical evidence showing that pre-school aged children expect generic information to be widely shared (Cimpian & Scott, 2012). Moreover, children before the age of 5 struggle to understand that some people (e.g. babies) may lack generic knowledge about the world (Caza, Atance & Bernstein, 2016).

However, when – for example – someone speaks in a different language or violates norms in cultural practices with tools, this assumption is contradicted. We suggest that it is a developing sensitivity to the violation of the universality assumption that serves as a starting point for the differentiation of social groups (i.e. there are people who do not know how we do things). Note that this conceptualization of social categorization necessarily involves the assumption that children start off with a default assumption that everyone is similar to them in terms of their body of (generic) knowledge and upon being presented with counterevidence, they slowly learn to suspend this general assumption and start to carve out the borders of social groups. As a first step, they start representing the social environment as “similar” and “dissimilar” others and the more experience they gain, the more fine-grained this representational system gets. This theory also predicts that initially, only the in-group is expected to have an organized set of knowledge (i.e. if someone has not shown evidence to possess different knowledge in one respect, this person will be expected to share knowledge with oneself in other respects as well); but children will have no specific expectations about how knowledge is organized for the out-group and whether and how the out-group should be further divided. This follows from the assumption that the default expectation is that knowledge is universally shared which will be kept only for the circle of people that do not contradict this assumption. Thus, parsing the social environment in this way does *not* equip children with default expectation about people who fall outside of this circle. Supposedly,

more experience and the development of sophisticated reasoning abilities are necessary to refine representations of out-groups as well.

Once children start representing the social environment in terms of categories derived from similarities and differences in knowledge states, this information can be used to organize knowledge obtained through social learning. Information received from “in-group” members will be regarded as more relevant to incorporate into our body of generic, cultural knowledge. However, this does not necessarily mean that children do not learn from out-group members at all. The fact that in selective imitation studies, children seem to represent the goal demonstrated by an out-group model even though they are less likely to reproduce an unusual means to arrive at it (Buttelmann et al., 2013; Howard et al., 2015; Oláh et al., 2016) suggests that they do extract knowledge from such demonstrations. Moreover, 4-year-old children are equally likely to copy the unnecessary elements of an action sequence in an overimitation paradigm when the demonstration had been performed by an in-group or an out-group member; although they are more likely to later omit these steps if in a subsequent demonstration they witness an in-group member (as opposed to an out-group member) do so (Altinok, Hernik, Király & Gergely, in prep). 4-year-old children have also been shown to remember the actions of an out-group member just as well as that of an in-group member, even though they restrict the use of objects for their learnt function only in the latter case (Pető et al., 2018). These results suggest that in order to maximize learning benefit, children encode information received from members of different groups; although not in the same manner.

The gap between infants’ and older children’s representations of social categories

A question that has to be answered is how social categorization transforms from this initial, simplistic function (that separates “us” from an unspecified “them”) to the very flexible and conceptually rich reasoning system that older children and adults possess. There are at least two points that any theory dealing with the origins of social categorization must address: first, at later stages of life, inferences based on social category information are extremely wide in scope and extend to dimensions that are not directly related to the one used to create the distinction in the first place (see the literature on stereotyping, e.g. Allport, 1950). For example, information about profession may result in conclusions about the person’s intelligence, personality traits or even likeability – inferences that cannot directly be derived from profession (only by associations). We do not find compelling evidence that young children similarly overstep domains in these inferences. Even cues that represent a meaningful distinction from early on, such as language, do not seem to carry the same weight in all aspects of social learning. For example, Buttelmann and colleagues (2013) have shown that while 14-month-old children selectively imitated the behavior of a linguistic in-group model, they did not selectively endorse their preferences of objects.

The second point pertains to the scope of social distinctions that are used to guide behavior and preferences. Namely, while young children seem to only focus on a few social distinctions (Kinzler & Spelke, 2011; Krieger, Möller, Zmyj & Aschersleben, 2016; Oostenbroek & Over, 2015; Shutts, Banaji & Spelke, 2010; but see Jin & Baillargeon (2017)), older children and adults accept even minimal groups as basis of inferences and attitudes (e.g. Tajfel et al., 1971; Turner et al., 1979). We suggest that since initially, the system has been evolved to reason about the knowledge states of fellow humans, it is inherently only sensitive to cues that children take as signals of knowledgeability. Naturally, as children gain more experience about their surroundings, the scope of such cues expands.

However, at one point in development, children manifest a tendency to generalize this inferential system to arbitrary social distinctions as well (e.g. Tajfel et al., 1971).

Although this is speculative, we believe it likely that these two changes may be linked to children's developing metacognitive abilities. That is, an understanding that people can be categorized and that these distinctions can be used to efficiently guide social interactions and save mental effort may tempt us to overapply social category based reasoning. In this process, humans seem to attach as much inferential power as possible to any information that can be coined as "category distinction" for the sake of mental economy and they try to derive information about anything that can be useful in predicting and interpreting the behavior of the other person (knowledge in various domains and also personality).

The involvement of metacognition in categorization may also explain why different cues of social categorization invite similar inferential processes despite their marked difference in relevance. It is reasonable to assume that the detection of differences in sex or religion, for example, serve very different functions with different adaptive values; however, in adults, their inclusion in reasoning related to stereotyping and prejudice shows massive resemblance. We suggest that a metacognitive concept of social categorization could unify these cues as inputs for the same inferential processes by applying the general idea that social categories define stable characteristics of a person. It is interesting to note that research suggests that it is somewhere between the ages of 3 and 5 that social categorization becomes more inclusive of various distinctions (e.g. Kinzler & Spelke, 2011) and this is exactly the time period that brings with it other important changes potentially related to metacognition in the development of theory of mind (Kuhn, 2000) or memory (Suddendorf & Corballis, 2007; Redshaw, 2014), for example.

Besides gaining an explicit understanding of how category labels may be used as a source of reasoning about human behavior, the growing amount of unjustified inferences are – no doubt – also the result of associations and what the social psychology literature calls “illusory correlation” (Chapman & Chapman, 1967).

The interplay of distinct social cognitive abilities

The above-described conceptualization of social categorization in terms of shared knowledge has important implications in what role it may play in social interactions. We propose that since social category representations are derived from cues of shared knowledge, they efficiently help us to fast-map the knowledge-states of fellow humans; therefore, social categorization is closely linked to mentalization processes.

A growing body of research suggests that humans from an early age are capable of forming simple predictions about the behavioral outcomes of mental states with ease (e.g. Onishi & Baillargeon, 2005; Southgate, Senju & Csibra, 2008; Low & Watts, 2013, Kamps, Parise, Csibra & Kovács, 2015; Hyde, Simon, Ting & Nikolaeva, 2018). Although it is currently debated whether such predictions are based on full-blown mentalization abilities (e.g. Apperly & Butterfill, 2009 but see Carruthers, 2016), such early emerging capacities are nevertheless important precursors for the ability to successfully partake in social interactions.

The role of mentalization in social learning and communication has been already considered in the literature emphasizing that information transmission from one individual to another will be most successful if the partners can correctly attribute goals, knowledge states, beliefs or desires to one another. The importance of this correspondence can be manifested in several ways and studies show that humans benefit from their mindreading abilities in information transfer scenarios from early stages of development. First, assessing the mental

states of a potential teacher is crucial in selecting knowledgeable informants. Studies show that young children can use both direct cues about knowledgeability, like prior accuracy or lack of information access (Koenig & Harris, 2005) and indirect ones, such as group membership (e.g. Buttelmann et al, 2013, see above) to maximize learning benefit. Second, during any information exchange, in order for the transaction to be successful, one must adjust their communication to the level of understanding of the partner. Evidence suggests that children (even from infancy) not only monitor the knowledge state and consequently reliability of potential informants but similarly take into account the other's mental states when they are sharing information with someone (Akhtar, Carpenter & Tomasello, 1996; Shwe & Markman, 1997; Moll, Koring, Carpenter & Tomasello, 2006; Kim, Kalish, Weisman, Johnson & Shutts, 2016). Moreover, reliance on mentalization makes it possible to appropriately decode the content of others' communications (Grice, 1957; Sperber & Wilson, 1986; see also experiments using the director task, c.f. Krauss & Glucksberg, 1977), and children apply this understanding in their emerging tendency to teach (Strauss, Ziv & Stein, 2002). Note also that the relationship between mentalization and social learning is bidirectional as experience with social interactions will naturally contribute to increasing the accuracy of mindreading processes.

While real-time processes of mentalization are crucial for making correct predictions about others' behavior in social interactions and are indispensable for smooth communication, some important pieces of information may not be derived from the ongoing interaction. Therefore, as opposed to the traditional conceptualization of mentalizing that focuses on the specifics of the current event only, it has recently been highlighted that we should also consider how mentalization may receive input from other cognitive functions (Westra, 2016; Spaulding, 2017; Tamir & Thornton, 2018). For example, Westra (2016) argues that stereotypes attached to social categories help individuals make attributions about

the character traits of another person based on group membership which will in turn help make predictions about the person's beliefs, desires, etc., and consequently about their actions.

Similarly, Spaulding (2017) brings attention to the fact that most acts of mental state attribution happen in an information-sparse context, leaving room for subjective interpretation of behavior. Thus, she suggests that in order to better understand theory of mind processes, it should also be noted that what is taken as input for mentalization varies with the characteristics of both the context and the agents involved. Moreover, there may also be marked differences in the resources allocated to the mentalization process based on the goals of the individual which may similarly affect the output of the process. The category membership of the social partners may modulate mental state attribution at both of these levels. For example, perceiving someone as more similar to us may lead us to project our own mental state onto the person for the sake of efficiency.

Our approach holds that the relationship between theory of mind and social categorization is even more direct than that. As described above, social categories may be formed based on perceived similarities between knowledge states, thus they inherently carry information about the body of shared knowledge one may possess. Therefore, category information directly warrants inferences about the background knowledge someone brings into the interaction.

Shared representational space

Humans can thus rely on two types of inferences when reasoning about the mental states of others: one that can be derived from social category information (a stable, slowly changing source of knowledge) and one that is based on the ongoing interaction (valid only in the given interaction and changing rapidly as it unfolds). We propose that the two

mechanisms work together in creating the mental context of the social interaction that we call *shared representational space*. The shared representational space thus includes the mentalizer's assumptions on what the partner knows about the world, based on both sources of information and consequently, whether and to what extent the partner's mental contents align or diverge from their own.

The shared representational space can be seen as a dynamically changing mental workspace between people engaging in a social interaction at a given time that includes assumptions about the background knowledge of the interaction partners (i.e. knowledge that can be attributed without engaging in any interaction) and is constantly updated as the interaction unfolds. The main form of attributed background knowledge is cultural knowledge which is why social category information is especially relevant for establishing a shared representational space. However, this is not the sole source of it, any piece of information that would warrant inferences about the knowledge state of a person may be used for the same purpose (e.g. knowing that the other person witnessed a particular event).

Our concept of shared representational space is similar to the concept of "common ground" in communication theories (Stalnaker, 2002), but in a broader sense. Similarly to Kecskés and Zhang's (2009) conceptualization of common ground, we emphasize that the shared representational space is shaped both by 1, a priori knowledge and assumptions and 2, experiences within the interaction. However, while Kecskés and Zhang assume two distinct types of common ground (emergent common ground and core common ground, where the former can be described as a set of assumptions shaped in the here-and-now and available only to the partners engaging in the particular communicative act, while the latter is defined as a more stable body of knowledge shared within a speech community), we conceive of shared representational space as a surface where the two types of input can be integrated.

Importantly, the shared representational space does not merely provide a workspace where social category information can enter mentalization processes. Rather, we claim that in our efforts to assess the epistemic state of a communicative partner during a social interaction, we also filter and learn information with generic power both about our physical (social learning) and social environment (updating social category representations or refining our impressions of a particular person).

Moreover, during any social interaction, we constantly update our representations of social agents and the structure of the social environment as well. For example, imagine that you initiate a lunch date with a person in a foreign country where - contrary to your home country – people nod when they disagree and shake their head when they agree. Your proposal is met by a shake of the head. Knowledge of the cultural difference would lead you to the correct attribution of the other's willingness to attend. In the absence of this piece of information the head gesture would signify rejection to you, unless it is accompanied by a contradicting verbal utterance as well. Such contradiction would elicit further computations of the intentions of the other person, potentially resulting in a revelation about the difference of cultural knowledge, thus leading to the refinement of your representation of the given social category.

An important aspect that differentiates our concept of shared representational space from similar concepts (such as common ground) is that the shared representational space is just as much a tool for updating stored knowledge as it is a workspace where different types of information may be integrated.

Figure 1. Schematic depiction of the shared representational space. The theory suggests that the reciprocal functioning of mentalization, social learning and social categorization makes it possible for humans to partake in successful social interactions with ease. Social categorization and theory of mind processes contribute to a rapid assessment of others' mental contents and consequently makes communicative interactions efficient, while the unfolding of the social interaction enriches these representational systems in turn. Moreover, we suggest that human-specific social learning processes lay the ground for children's proneness to represent the social world in terms of categories.

Empirical evidence

The theory we put forth yields specific predictions for research. First, although in some cases people (even in infancy) may prefer to engage in a social interaction with in-group, rather than out-group members, this is not necessarily driven by a general preference, but is determined by the purposes of the interaction (e.g. social learning). Moreover, we argue that since social categorization has not evolved to represent clear-cut, stable social distinctions but to help us make sense of the constantly changing relevance of an endless

number of possible social distinctions, it would not be adaptive to refuse to mentalize out-groups per se (e.g. one is still motivated to mentalize a family member even though they may belong to different categories based on profession, sports team or political views). Thus, we argue that in general, people would be equally motivated to assess the mental states of out-group members, however, they would invest more effort in mentalization when they detect a difference in the relevant dimension of group membership as this would indicate that the short-cut of generalizing their own knowledge to the other person may not be valid. Although at this point, empirical evidence is sparse on this question, a few studies suggest that the group membership of the interactional partner modulates theory of mind processes. For example, in a visual perspective task, participants' own perspective interfered more with calculating the perspective of an in-group member than an out-group member, suggesting a stronger propensity to generalize first-person mental content to an in-group (Simpson & Todd, 2017). Another study (Todd, Hanko, Galinsky & Mussweiler, 2011) showed that in a coordination task where participants have to take into account that their visual perspective differs from that of the social partner, people are better at solving the task if they participate with an out-group member (based on minimal group distinctions).

The effect of group membership has also been shown in relation to more complex forms of mentalization. Todd and colleagues (2011), for example, have shown that adults are better at reasoning of the false belief of an out-group member than that of an in-group member. Moreover, in an unexpected content task, Seehagen, Dreier and Zmyj (2018) found that 4-year-old children were more likely to correctly attribute a false belief to a peer than to an adult, suggesting that the expectation that the adult should be knowledgeable hindered theory of mind processes. Categorization by age is also relevant with respect to the informational state of the other person as adults are more likely to be in possession of

culturally relevant knowledge. Therefore, the result that children expect an adult to be in possession of knowledge they had just learned about is in line with our theory.

Chalik, Rivera and Rhodes (2014) have shown that children initially rely on category information to predict harming behavior between individuals, but as they mature, they rely more on a refined assessment of the mental states of individuals (around the age of 4). Although the focus of this study was not on the knowledge or belief states of others (rather their intentions), these results point out that younger children possess a default bias to generalize mental states to a group of people. Moreover, they also suggest that young children's failure in mental state attribution may not simply be explained by a first-person bias but by a more general tendency to view mental states as shared or universal (at least within groups).

A seemingly contradictory finding was presented by McLoughlin and Over (2017) who have shown that 5-6-year-old children are more likely to use mentalistic terms to describe the behavior of agents categorized as "in-group" than agents categorized as "out-group". However, the increased use of mentalistic terms may simply reflect that children view the mental states of in-group members as more easily accessible than those of out-group members (which may originate from the universality bias).

It is important to note that while our theory predicts that, by default, we should not be less motivated to mentalize an out-group (see above), humans certainly seem to have a tendency to deprive out-groups from human-specific forms of mental states, a phenomenon known as dehumanization (Haslam, 2006). While empirical evidence is lacking to fully understand the cognitive mechanisms behind dehumanization, we suggest that this may be a dysfunctional consequence of realizing that assessing the mental states of an out-group

member requires more effort and is more likely to result in failure. It is possible that under certain circumstances this may lead the system to shut down altogether.

Concluding remarks

The aim of this paper was to highlight the fact that sophisticated reasoning about the social environment depends on the interaction of cognitive functions that have traditionally been investigated in isolation. We suggest that the common root of these processes is humans' fundamental motivation to maximize learning benefit about their environment and the fact that humans acquire most of their knowledge from conspecifics provides unique opportunities to learn about their social environment at the same time.

References

- Akhtar, N., Carpenter, M., & Tomasello, M. (1996). The role of discourse novelty in early word learning. *Child Development*, 67(2), 635-645. <https://doi.org/10.1111/j.1467-8624.1996.tb01756.x>
- Allport, G. W. (1950). *Prejudice*. Association Press.
- Apperly, I. A., & Butterfill, S. A. (2009). Do humans have two systems to track beliefs and belief-like states?. *Psychological review*, 116(4), 953.
<http://dx.doi.org/10.1037/a0016923>
- Buttelmann, D., Zmyj, N., Daum, M., & Carpenter, M. (2013). Selective imitation of in-group over out-group members in 14-month-old infants. *Child Development*, 84(2), 422-428. <https://doi.org/10.1111/j.1467-8624.2012.01860.x>
- Call, J., & Tomasello, M. (2008). Does the chimpanzee have a theory of mind? 30 years later. *Trends in cognitive sciences*, 12(5), 187-192.
<https://doi.org/10.1016/j.tics.2008.02.010>
- Carruthers, P. (2016). Two systems for mindreading?. *Review of Philosophy and Psychology*, 7(1), 141-162. <https://doi.org/10.1007/s13164-015-0259-y>
- Chalik, L., Rivera, C., & Rhodes, M. (2014). Children's use of categories and mental states to predict social behavior. *Developmental Psychology*, 50(10), 2360.
<http://dx.doi.org/10.1037/a0037729>
- Chapman, L. J. (1967). Illusory correlation in observational report. *Journal of Verbal Learning and Verbal Behavior*, 6(1), 151-155. [https://doi.org/10.1016/S0022-5371\(67\)80066-5](https://doi.org/10.1016/S0022-5371(67)80066-5)

- Crisp, R. J., & Hewstone, M. (2007). Multiple social categorization. *Advances in experimental social psychology*, 39, 163-254. [https://doi.org/10.1016/S0065-2601\(06\)39004-1](https://doi.org/10.1016/S0065-2601(06)39004-1)
- Csibra, G., & Gergely, G. (2006). Social learning and social cognition: The case for pedagogy. *Processes of change in brain and cognitive development. Attention and performance XXI*, 21, 249-274.
- Csibra, G., & Gergely, G. (2009). Natural pedagogy. *Trends in cognitive sciences*, 13(4), 148-153. <https://doi.org/10.1016/j.tics.2009.01.005>
- Csibra, G., & Gergely, G. (2011). Natural pedagogy as evolutionary adaptation. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 366(1567), 1149-1157. <https://doi.org/10.1098/rstb.2010.0319>
- Fiske, S. T. (2000). Stereotyping, prejudice, and discrimination at the seam between the centuries: Evolution, culture, mind, and brain. *European Journal of Social Psychology*, 30(3), 299-322. [https://doi.org/10.1002/\(SICI\)1099-0992\(200005/06\)30:3<299::AID-EJSP2>3.0.CO;2-F](https://doi.org/10.1002/(SICI)1099-0992(200005/06)30:3<299::AID-EJSP2>3.0.CO;2-F)
- Gergely, G., & Csibra, G. (2005). A few reasons why we don't share Tomasello et al.'s intuitions about sharing. *Behavioral and Brain Sciences*, 28(5), 701-702. <https://doi.org/10.1017/S0140525X05330123>
- Grice, H. P. (1975). " Logic and conversation" In Cole, P., and Morgan, J.(Eds.). *Syntax & Semantics*, 3.
- Haslam, N. (2006). Dehumanization: An integrative review. *Personality and social psychology review*, 10(3), 252-264. https://doi.org/10.1207/s15327957pspr1003_4

- Henrich, J. (2004). Cultural group selection, coevolutionary processes and large-scale cooperation. *Journal of Economic Behavior & Organization*, 53(1), 3-35.
[https://doi.org/10.1016/S0167-2681\(03\)00094-5](https://doi.org/10.1016/S0167-2681(03)00094-5)
- Herrmann, E., Call, J., Hernández-Lloreda, M. V., Hare, B., & Tomasello, M. (2007). Humans have evolved specialized skills of social cognition: The cultural intelligence hypothesis. *science*, 317(5843), 1360-1366. DOI: 10.1126/science.1146282
- Howard, L. H., Henderson, A. M., Carrazza, C., & Woodward, A. L. (2015). Infants' and Young Children's Imitation of Linguistic In- Group and Out- Group Informants. *Child development*, 86(1), 259-275. <https://doi.org/10.1111/cdev.12299>
- Hyde, D. C., Simon, C. E., Ting, F., & Nikolaeva, J. I. (2018). Functional Organization of the Temporal–Parietal Junction for Theory of Mind in Preverbal Infants: A Near-Infrared Spectroscopy Study. *Journal of Neuroscience*, 38(18), 4264-4274.
<https://doi.org/10.1523/JNEUROSCI.0264-17.2018>
- Jin, K. S., & Baillargeon, R. (2017). Infants possess an abstract expectation of ingroup support. *Proceedings of the National Academy of Sciences*, 114(31), 8199-8204.
<https://doi.org/10.1073/pnas.1706286114>
- Kampis, D., Parise, E., Csibra, G., & Kovács, Á. M. (2015). Neural signatures for sustaining object representations attributed to others in preverbal human infants. *Proceedings of the Royal Society B: Biological Sciences*, 282(1819), 20151683.
<https://doi.org/10.1098/rspb.2015.1683>

- Kecskes, I., & Zhang, F. (2009). Activating, seeking, and creating common ground: A socio-cognitive approach. *Pragmatics & Cognition*, 17(2), 331-355.
<https://doi.org/10.1075/pc.17.2.06kec>
- Kim, S., Kalish, C. W., Weisman, K., Johnson, M. V., & Shutts, K. (2016). Young children choose to inform previously knowledgeable others. *Journal of Cognition and Development*, 17(2), 320-340. <https://doi.org/10.1080/15248372.2014.952731>
- Kinzler, K. D., Shutts, K., & Correll, J. (2010). Priorities in social categories. *European Journal of Social Psychology*, 40(4), 581-592. <https://doi.org/10.1002/ejsp.739>
- Kinzler, K. D., & Spelke, E. S. (2011). Do infants show social preferences for people differing in race?. *Cognition*, 119(1), 1-9.
<https://doi.org/10.1016/j.cognition.2010.10.019>
- Koenig, M. A., & Harris, P. L. (2005). Preschoolers mistrust ignorant and inaccurate speakers. *Child development*, 76(6), 1261-1277. <https://doi.org/10.1111/j.1467-8624.2005.00849.x>
- Krauss, R., & Glucksberg, S. (1977). Social and Nonsocial Speech. *Scientific American*, 236(2), 100-105. <http://www.jstor.org/stable/24953896>
- Krieger, A. A., Möller, C., Zmyj, N., & Aschersleben, G. (2016). Tom is not more likely to imitate Lisa than Ying: The influence of a model's race indicated by physical appearance on children's imitation. *Frontiers in psychology*, 7, 972.
<https://doi.org/10.3389/fpsyg.2016.00972>
- Kuhn, D. (2000). Metacognitive development. *Current directions in psychological science*, 9(5), 178-181. <https://doi.org/10.1111/1467-8721.00088>

- Kurzban, R., Tooby, J., & Cosmides, L. (2001). Can race be erased? Coalitional computation and social categorization. *Proceedings of the National Academy of Sciences*, 98(26), 15387-15392. <https://doi.org/10.1073/pnas.251541498>
- Liberman, Z., Woodward, A. L., & Kinzler, K. D. (2017). The origins of social categorization. *Trends in cognitive sciences*, 21(7), 556-568. <https://doi.org/10.1016/j.tics.2017.04.004>
- Lieberman, D., Oum, R., & Kurzban, R. (2008). The family of fundamental social categories includes kinship: Evidence from the memory confusion paradigm. *European Journal of Social Psychology*, 38(6), 998-1012. <https://doi.org/10.1002/ejsp.528>
- Low, J., & Watts, J. (2013). Attributing false beliefs about object identity reveals a signature blind spot in humans' efficient mind-reading system. *Psychological Science*, 24(3), 305-311. <https://doi.org/10.1177/0956797612451469>
- McLoughlin, N., & Over, H. (2017). Young children are more likely to spontaneously attribute mental states to members of their own group. *Psychological Science*, 28(10), 1503-1509. <https://doi.org/10.1177/0956797617710724>
- Moll, H., Koring, C., Carpenter, M., & Tomasello, M. (2006). Infants determine others' focus of attention by pragmatics and exclusion. *Journal of Cognition and Development*, 7(3), 411-430. https://doi.org/10.1207/s15327647jcd0703_9
- Oláh, K., Elekes, F., Bródy, G., & Király, I. (2014). Social category formation is induced by cues of sharing knowledge in young children. *PloS one*, 9(7), e101680. <https://doi.org/10.1371/journal.pone.0101680>

- Oláh, K., Elekes, F., Pető, R., Peres, K., & Király, I. (2016). 3-Year-Old Children Selectively Generalize Object Functions Following a Demonstration from a Linguistic In-group Member: Evidence from the Phenomenon of Scale Error. *Frontiers in psychology*, 7, 963. <https://doi.org/10.3389/fpsyg.2016.00963>
- Oláh, K., & Király, I. (2019). Young Children Selectively Imitate Models Conforming to Social Norms. *Frontiers in psychology*, 10. [10.3389/fpsyg.2019.01399](https://doi.org/10.3389/fpsyg.2019.01399)
- Onishi, K. H., & Baillargeon, R. (2005). Do 15-month-old infants understand false beliefs?. *Science*, 308(5719), 255-258. DOI: 10.1126/science.1107621
- Oostenbroek, J., & Over, H. (2016). The cultural transmission of social information. In S. S. Obhi, & E. S. Cross (Eds.), *Shared representations: Sensorimotor foundations of social life* (pp. 136–151). Cambridge: Cambridge University Press.
- Pető, R., Elekes, F., Oláh, K., & Király, I. (2018). Learning how to use a tool: Mutually exclusive tool–function mappings are selectively acquired from linguistic in-group models. *Journal of experimental child psychology*, 171, 99-112. <https://doi.org/10.1016/j.jecp.2018.02.007>
- Pietraszewski, D., & Schwartz, A. (2014). Evidence that accent is a dimension of social categorization, not a byproduct of perceptual salience, familiarity, or ease-of-processing. *Evolution and Human Behavior*, 35(1), 43-50. <https://doi.org/10.1016/j.evolhumbehav.2013.09.006>
- Redshaw, J. (2014). Does metarepresentation make human mental time travel unique?. *Wiley Interdisciplinary Reviews: Cognitive Science*, 5(5), 519-531. <https://doi.org/10.1002/wcs.1308>

- Rhodes, M., & Chalik, L. (2013). Social categories as markers of intrinsic interpersonal obligations. *Psychological science*, 24(6), 999-1006.
<https://doi.org/10.1177/0956797612466267>
- Richerson, P. J., & Boyd, R. (1998). The evolution of human ultra-sociality. *Indoctrinability, ideology, and warfare: Evolutionary perspectives*, 71-95.
- Romney, A. K. (1999). 2 Cultural Consensus as as a Statistical Model. *Current Anthropology*, 40(S1), S93-S115.
- Shwe, H. I., & Markman, E. M. (1997). Young children's appreciation of the mental impact of their communicative signals. *Developmental Psychology*, 33(4), 630.
<http://dx.doi.org/10.1037/0012-1649.33.4.630>
- Seehagen, S., Dreier, L., & Zmyj, N. (2018). Overrated adults: 4-year-olds' false belief understanding is influenced by the believer's age. *Journal of experimental child psychology*, 167, 328-335. <https://doi.org/10.1016/j.jecp.2017.11.007>
- Sherif, M., Harvey, O. J., White, B. J., Hood, W. R., & Sherif, C. W. (1961). *Intergroup cooperation and conflict: The robbers cave experiment*. Norman, OK: University of Oklahoma Book Exchange.
- Shutts, K., Banaji, M. R., & Spelke, E. S. (2010). Social categories guide young children's preferences for novel objects. *Developmental science*, 13(4), 599-610.
doi.org/10.1111/j.1467-7687.2009.00913.x
- Sidanius, J., Pratto, F. (1993). The inevitability of oppression and the dynamics of social dominance. In P. Sniderman, P. Tetlock (Eds.). *Prejudice, politics, and the American dilemma* (pp. 173-211). Stanford, CA: Stanford University Press.

- Simpson, A. J., & Todd, A. R. (2017). Intergroup visual perspective-taking: Shared group membership impairs self-perspective inhibition but may facilitate perspective calculation. *Cognition*, 166, 371-381.
<https://doi.org/10.1016/j.cognition.2017.06.003>
- Soley, G., & Aldan, P. (2018). Children and adults selectively attribute shared cultural knowledge to speakers of the same language. *Child development*.
<https://doi.org/10.1111/cdev.13161>
- Soley, G., & Spelke, E. S. (2016). Shared cultural knowledge: Effects of music on young children's social preferences. *Cognition*, 148, 106-116.
<https://doi.org/10.1016/j.cognition.2015.09.017>
- Southgate, V., Senju, A., & Csibra, G. (2007). Action anticipation through attribution of false belief by 2-year-olds. *Psychological Science*, 18(7), 587-592.
<https://doi.org/10.1111/j.1467-9280.2007.01944.x>
- Spaulding, S. (2017). Do you see what I see? How social differences influence mindreading. *Synthese*, 1-22. <https://doi.org/10.1007/s11229-017-1404-1>
- Sperber, D., & Wilson, D. (1986). *Relevance: Communication and cognition* (Vol. 142). Cambridge, MA: Harvard University Press.
- Stalnaker, R. (2002). Common ground. *Linguistics and philosophy*, 25(5), 701-721.
- Strauss, S. Ziv, M., Stein, A. (2002). Teaching as a natural cognition and its relations to preschoolers' developing theory of mind. *Cognitive Development* 17. 1473–1787.
[https://doi.org/10.1016/S0885-2014\(02\)00128-4](https://doi.org/10.1016/S0885-2014(02)00128-4)

- Suddendorf, T., & Corballis, M. C. (2007). The evolution of foresight: What is mental time travel, and is it unique to humans?. *Behavioral and brain sciences*, 30(3), 299-313.
<https://doi.org/10.1017/S0140525X07001975>
- Tajfel, H., Billig, M., Bundy, R. P. and Flament, C. (1971). Social categorization and intergroup behaviour. *European Journal of Social Psychology*, Vol. 1, Issue 2, 149-178. <https://doi.org/10.1002/ejsp.2420010202>
- Tamir, D. I., & Thornton, M. A. (2018). Modeling the predictive social mind. *Trends in cognitive sciences*, 22(3), 201-212. <https://doi.org/10.1016/j.tics.2017.12.005>
- Todd, A. R., Hanko, K., Galinsky, A. D., & Mussweiler, T. (2011). When focusing on differences leads to similar perspectives. *Psychological Science*, 22(1), 134-141.
<https://doi.org/10.1177/0956797610392929>
- Tomasello, M., Carpenter, M., Call, J., Behne, T., & Moll, H. (2005). Understanding and sharing intentions: The origins of cultural cognition. *Behavioral and brain sciences*, 28(5), 675-691. <https://doi.org/10.1017/S0140525X05000129>
- Turner, J. C., Hogg, M. A., Oakes, P. J., Reicher, S. D., & Wetherell, M. S. (1987). *Rediscovering the social group: A self-categorization theory*. Basil Blackwell.
- Westra, E. (2017). Stereotypes, theory of mind, and the action–prediction hierarchy. *Synthese*, 1-26. <https://doi.org/10.1007/s11229-017-1575-9>