



# Corvids and the understanding of mental states: Theory of mind or theory of mind-like?

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## Abstract

Birds such as jays, magpies and crows have been observed to engage in behaviour that suggests an ability to infer from mental states. Re-caching behaviour when observed during caching, which refers to the behaviour of re-hiding already hidden food stores, is a common example. Furthermore, various strategies to prevent the potential pilfering of their food stores, such as interrupting their caching, retrieving their food, and caching as far away from the observer as possible, are additional examples. Two explanations have been provided for these observations. Firstly, that they indicate an understanding of visual perspectives as well as an ability to infer from mental states, or a 'theory of mind'. The second is that they simply apply previously learned behavioural rules to their situations, that is, the argument that all these behaviours are resultant of associative learning. The second explanation, though cognitively simpler, implies a need for a wide variety of versatile rules that would govern their behaviour. There has not been enough empirical evidence to support this theory in comparison to the former. On the exploration of findings from various behavioural studies on corvids, this paper argues that the evidence seen in support of the hypothesis that corvids do possess a theory of mind is more compelling than any evidence suggesting otherwise.

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## I. Introduction

According to the American Psychological Association, theory of mind refers to 'the understanding that others have intentions, desires, beliefs, perceptions, and emotions different from one's own and that such intentions, desires, and so forth affect people's actions and behaviours' (American Psychological Association, n.d.).

The idea of a Theory of Mind (henceforth ToM) was first explored not by cognitive scientists, but by Primatologists, who investigated this ability extensively in primates. Premack & Woodruff (1978) looked at the understanding of intentionality in chimpanzees, and found that they can, to an extent, understand intentionality and purpose, and can choose solutions that are compatible with said purpose. This research allowed for an understanding that the ability to represent the mental states of others and use these representations to manipulate and understand behaviour may not be exclusive to humans. Over time, more evidence to show that some nonhuman monkeys and apes, such as chimpanzees and rhesus macaques can attribute mental states to conspecifics was discovered (Call & Tomasello, 2008; Martcorena et al., 2011). Further to this, the questions that concerned comparative psychologists the most were not whether humans are unique in this respect, but whether the ability to attribute mental states was unique to primates. For example, do corvids possess the ability to understand intentionality and attribute mental states to other conspecifics? The aim of this paper is to explore the findings from a variety of behavioural studies on corvids, and to argue that the available evidence supports the hypothesis that they can attribute mental states to conspecifics and do not just exhibit ToM-like behaviour.

## Why is it important to study animal ToM? Some historical background

According to Gómez (1959), "we have an irresistible tendency to translate behaviour into mental states, to represent what people do in terms of what they want and what they know and don't know" (Gómez, 205). Studying ToM in non-human animals gives us a reference into the distinctions between our cognitive processes and those of different animals, which allows us to understand how we differ cognitively from other species. For example, a review paper by Call & Tomasello (2011) highlighted that human beings and chimpanzees share more than a just simple understanding of behaviours that can be used to make inferences about the mental states

of others. In fact, it has been seen that chimpanzees and humans have a comparable ability in the understanding of how the mental states of others translate into intentional action. These similarities between us and our closest evolutionary relatives have allowed us to better understand how we have evolved in comparison to them. It also allows for us to better understand the origins of this capability, as well as recognise the development of it over time, as years of research on ToM in human children still has not produced a definite consensus on whether we possess the ability to understand intentionality before the age of three or four (Tsoukalas, 2018). Further research on primates has shown that the similarities between human and ape ToM comes mostly from the similarities in their patterns of social behaviour, though human beings have developed a cognitive specialisation that other great apes have not. (Povinelli & Preuss, 1995). On learning that primates do, to an extent, possess a ToM, the horizons of cognitive research were expanded to include other animals, such as corvids, for example.

### **Evidence supporting Corvid ToM**

A prominent example of such research was done by Dally, Emery & Clayton (2009), who examined re-caching behaviour in western scrub-jays. In the wild, these birds would compete for 'valuable' food, such as high fat and protein scraps left by humans, and would cache the food. However, it was observed that many would return to their caches when other birds were distracted, and would re-hide the caches in new locations so as to protect their food from conspecific raiders and pilferers. This natural behaviour suggested that the jays may possess the understanding of the difference between conspecifics that know the location of the cache sites, and those who were ignorant of the same. On testing this re-caching behaviour in the laboratory by allowing the jays to cache worms in an observed and unobserved setting, and then giving them an opportunity to re-cache after an interval of time, a couple of observations were made. Firstly, the jays would attempt to reduce the amount of visual information they were giving to potential pilferers by caching either out of sight or as far away as possible from other conspecifics. Secondly, when observed during primary caching, jays tend to re-cache in new locations, but do not do this when the conspecific's vision was occluded during primary caching. Finally, only those jays with prior experience of being a pilferer re-cache their food after being observed. These observations suggest that the jays possess an ability to understand visual perspectives of others, as they cache their food while attempting to reduce the amount of visual information they give to observers. Furthermore, they have the ability to attribute knowledge to others as they only re-cache when observed the first time and have the ability to project prior experience onto conspecifics, as only jays who have pilfered before re-cache their food. These observations support the idea that jays have the ability to attribute mental states to others, and take action according to the same.

Like scrub-jays, ravens are also seen to exhibit re-caching and pilfering behaviour. Bugnyar & Kotrschal (2002) sought to understand the impact of observational spatial memory of food caching and raiding behaviours. Ravens were seen to respond to each others' presence, which indicates the importance of visual observation in caching and raiding. When observed during caching, ravens would interrupt caching, recover their food items, or change their cache sites as a way to manipulate the observer's attention to avoid giving away too much visual information about their food cache. These observations suggested that ravens display a form of 'tactical' deception, which implies an intrinsic understanding of an observer's intentions and mental states. If the ravens were ignorant to the fact that conspecific observers are potential raiders, there would be no need or motivation to employ deceptive strategies to reduce and manipulate the visual information they were giving away about their food cache. However, since there has been an observed pattern of deceptive behaviour with regards to food caching, it can be said that ravens can infer mental states of conspecifics and manipulate their actions to suit their needs in their situation.

Another argument for corvid ToM was made by Emery (2004), who argued that corvids could be called 'feathered apes'. This is because the shared and relatively recent evolution of birds and mammals, both of which appeared around 65 million years ago could explain the similarities in corvid and mammalian cognition. Eurasian and North American Jays feed mostly on seeds and acorns, and inhabit mostly forested areas, much like the primitive corvids, and are therefore much closely related to them. In comparison, crow-like birds such as magpies have moved into more open spaces and are thus less dependent on seeds for food, and have adapted to become omnivorous. This means that they are now less constrained by their habitat, and are a lot more mobile, which according to Emery (2004), suggests that they are the most recently evolved of the corvids. Their more recent adaptation may account for their superior cognitive abilities as compared to other birds (Clayton & Emery, 2005). Wyles, Kunkel & Wilson (1983) suggests that because mammals and birds demonstrate comparable rates of anatomical evolution, they may also demonstrate comparable rates of cognitive evolution. From this perspective, the similarities in the adaptive and evolutionary patterns in birds and mammals may account for their remarkable cognitive abilities and the similarity between the two.

An important social indicator of understanding of others' perception and attention is the ability to follow gaze, i.e. the ability to follow the head and eye direction of another individual. In an attempt to understand the importance of gaze following in corvids' ability to understand intentionality, Bugnyar, Stöwe & Heinrich (2004) conducted an experiment to see whether ravens could follow human gaze direction around obstacles. Gaze

direction is seen as a very important behavioural cue for social animals such as primates (Bugnyar, Stöwe & Heinrich, 2004), but in most studies has been seen with the participant having no understanding that others' view may not be the same as their own. The results of the study found that ravens can not only follow the gaze of the human experimenter, but also move to reposition themselves to follow the gaze beyond a visual barrier. This suggests that ravens do have the ability to understand that their visual access and that of others can differ on the basis of perspective, and also that they are able to attribute significance to the visual behaviour of others. In another experiment on visual behavioural cues, Bugnyar, Reber & Buckner (2016) conducted an experiment to see whether ravens can attribute visual access to unseen rivals. What they found was that ravens have the ability to infer being seen, as they would guard their caches in response to sounds of conspecifics from the other side of a peephole, but only when the peephole was open. This could imply that ravens have the ability to discern the possibility of being seen from their own personal perceptual experience. The results of these two studies provide strong evidence for ravens' abilities to understand the perceptions of others, and also infer the visual access of others- unique abilities that contribute to the overall understanding of intentionality, and hence strengthening the argument that corvids do possess a ToM.

### **Alternative theories to Corvid ToM**

Though there is a plethora of support for the idea that corvids can understand intentionality and hence possess a ToM, there is still criticism that suggests otherwise. There are a number of critiques of ToM in animals, more prominently, a critique by Penn & Povinelli (2007), who argue that animals react to certain behavioural and contextual cues that they have encountered previously in interactions with conspecifics, not that they can attribute knowledge and visual perspectives to others. In the context of the caching studies, the birds could have learned a rule about the relationship between a set of observable cues and behaviour, such as "re-cache food if a conspecific's line of gaze is associated with it" (Penn & Povinelli, 2007). However, corvids do have rather versatile cache protection strategies, and they have not been found to re-cache when presented with mirror images of themselves when caching (Dally, Emery & Clayton, 2010). This means that they do not follow a single rule to re-cache when there is a conspecific observing them, but would either need a set of very dynamic rules, or they do understand visual perspectives. There is also a significant lack of literature on behaviour-reading accounts, as they have not been tested positively and they only appear as post-hoc ideas, after the results of newer ToM tasks are reported, which gives these criticisms a lot less validity (Brecht, 2017).

A critique of the paper by Bugnyar et al. (2016), which showed that ravens can take account of the visual access of others, cites that the experiment did not employ a method that can determine whether or not ravens represent 'seeing' (Povinelli et al, 2020). The critique states that the experimenters did not take into account whether or not the birds were following a rule based on previous behavioural cues (such as the ones discussed by Penn and Povinelli (2007)), and that there were two specific challenges associated with this that undermine the ToM inferences made by Bugnyar et al. (2016). Firstly, there is the fact that animals can form perceptual representations of their environments and relations between the objects within it, and that these representations persist over time. This ability does not qualify as reasoning about mental states due to the fact that these representations can be retrieved at any time, and therefore comprise of perceptual memory rather than inferring of and reasoning about mental states. Secondly, an animal cannot keep track of what another has seen or not seen without keeping in mind the physical juxtaposition of the objects in their environment, which is a first-order perceptual representation. However, they can keep the latter in mind without having an understanding of mental states such as 'seeing'. Povinelli et al (2020) say that there is therefore an asymmetrical connection between first and higher order mental states, as having perceptual memory does not equate to having the ability to understand intentionality, which is a higher-order mental state. These critiques also tie into those made by Penn & Povinelli (2007) as they focus largely on the idea that animals follow sets of rules determined by instinct and social learning. Hence their behaviour is not determined by the projection of mental states, but as a result of learning from behavioural cues. However, as stated above, this cannot be entirely possible as this would mean the behavioural rules they follow would need to be very versatile, an idea that has not been studied in detail as yet, and thus has little to no evidence to back it so far.

Another counter idea to ToM in corvids was put forward by van der Vaart, Verbrugge, & Hemelrijk (2012), who suggested that re-caching behaviour in scrub jays could have an explanation that does not rely on complex cognition such as the ability to reason about others' mental states. They suggested that scrub jays simply have a desire to cache more, which is a direct result of stress from being watched during their caching process, as well as from unsuccessful cache recovery attempts in the past. In order to avoid the most frequently seen drawback of behavioural explanations to re-caching behaviour, which is that the hypothesis requires different rules for every caching behaviour, they explained a variety of behavioural patterns as being the results of stress. This hypothesis was tested on a 'virtual bird', whose behaviours depended on a pre-determined set of assumptions about corvid cognition, as well as a model of human memory. What they observed was that the 'virtual bird' behaved in the same way real birds did, depending on a variety of factors which included whether

they were being watched during caching, the dominance of their onlookers, and how close their onlooker was to them. Since the ‘virtual bird’ did not have the ability to attribute mental states, the conclusion was drawn that its behaviour was caused by previously learned mental states, and that corvid re-caching can hence be explained without the need for complex cognition. Though these conclusions are positive, the lack of empirical testing of this theory is again a major drawback.

## II. Conclusion

The primary evidence for corvids possessing a ToM is the re-caching behaviour they display when watched by conspecifics during primary caching (Emery, 2003; Dally, Emery & Clayton, 2009; Bugnyar&Kotrschal, 2002). Other evidence in support of this idea came from evolutionary theory, which proposed that the shared patterns of adaptation between mammals and corvids may account for their superior cognitive abilities (Emery, 2001). Furthermore, the similarities in anatomical evolution of corvids and mammals may also imply a similarity in their cognitive evolution, which may prove as an explanation for the remarkable cognitive abilities of corvids (Wyles et al, 1983). The ability to account for others’ visual access, as well as the ability to accurately follow gaze and understand conspecific perspectives also prove to be compelling arguments for corvid ToM (Bugnyar, Reber& Buckner, 2016; Bugnyar, Stowe & Heinrich, 2004). Though it is feasible that re-caching behaviour may be caused by stress from being watched during caching (van der Vaart, Verbrugge&Hemeljirik, 2012), or simply because corvids follow a set of behavioural rules that tell them to cache more depending on whether they’re being watched (Povinelli et al, 2020; Penn & Povinelli, 2007), the empirical evidence to support these ideas are limited. Furthermore, van der Vaart, Verbrugge&Hemeljirik (2012) argue that the only reason corvids re-cache is to prevent unsuccessful recovery attempts. If this was the case, surely they would re-cache regardless of whether they were being observed.

If re-caching behaviour is caused by stress rather than an understanding of intentionality, and the behavioural responses are adaptive then the only thing left to argue is the internal workings of the bird’s brain, a concept which is very difficult to assess. For these reasons, and based on the empirical evidence presented in this paper, the arguments made in support of corvid ToM and their understanding of intentionality seems far more compelling than the evidence presented against it.

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