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Reference in human and non-human primate communication: What does it take to refer?

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Abstract The concept of functional reference has been used to isolate potentially referential vocal signals in animal communication. However, its relatedness to the phenomenon of reference in human language has recently been brought into question. While some researchers have suggested abandoning the concept of functional reference altogether, others advocate a revision of its definition to include contextual cues that play a role in signal production and perception. Empirical and theoretical work on functional reference has also put much emphasis on how the *receiver* understands the referential signal. However, reference, as defined in the linguistic literature, is an action of the *producer*, and therefore, any definition describing reference in non-human animals must also focus on the producer. To successfully determine whether a signal is used to refer, we suggest an approach from the field of pragmatics, taking a closer look at specific situations of signal production, specifically at the factors that influence the production of a signal by an individual. We define the concept of *signaller's reference* to identify intentional acts of reference produced by a signaller independently of the communicative modality, and illustrate it with a case study of the hoo vocalizations produced by wild chimpanzees during travel. This novel framework introduces an intentional approach to referentiality. It may therefore permit a closer comparison of human and non-human animal referential behaviour and underlying cognitive processes, allowing us to identify what may have emerged solely in the human lineage.

Keywords Animal communication · Cognition · Reference · Language evolution · Semantics · Pragmatics

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Introduction

Reference is a notion with a long tradition in animal communication research (Cheney and Seyfarth 1996; Marler et al. 1992), most prominently applied through the more delimited concept of *functional reference* (Bugnyar et al. 2001; Clay et al. 2012; Evans and Evans 1999; Kalan et al. 2015; Price et al. 2015). This concept did not originally aim to compare referential signals in non-human animals with human referential signals (Wheeler and Fischer 2015). Nevertheless, recent scientific approaches to referentiality have sought to define a concept that could also explain how human language evolved from earlier, simpler forms of animal communication (Liebal et al. 2014; Scarantino and Clay 2015). The referential use of a signal (including human words) in communication appears indeed to be an elementary feature of any communication system. Referring to something in the world may be the most basic form of triangular communication (Allen and Saidel 1998; Hurford 2007; Tomasello 2008). Given this, the concept of reference seems to be a good starting point for comparative research in order to understand how human language as a communicative tool may have evolved. The aim of this paper is to provide a framework for such comparison between referential human words and potentially referential animal signals by merging the

criteria for intentionality and referentiality. In doing so, we aspire to provide a fixed, universal framework applicable to a specific situation of signal production, independent of the communicative modality. This framework will be based on the assumption that in order to refer with signals the way humans do, the signal producer must have an *intention* to refer. This intention to refer might be present if the signaller flexibly produces the signal, depending on contextual changes. We first summarize the conceptual framework, mainly inspired from semantics, which has supported previous analyses of animal referential signalling. We then present a framework inspired by linguistic pragmatics to analyse a type of reference that we name *signaller's reference*, described in the human literature but absent in the animal literature. Finally, we exemplify this framework with vocalizations produced by wild chimpanzees during travel.

Why is animal reference important and what notion of reference are we actually looking for?

Up to now, discussions about referential animal signals have been dominated by the concept of functional reference (Wheeler and Fischer 2012). This concept appears to be related to semantic reference of human words: it abstracts from signallers and attempts to identify signals and their referents. Signals are functionally referential if they are "elicited by a special class of stimuli and capable of causing behaviours adaptive to such stimuli *in absence of contextual cues*" (Macedonia and Evans 1993: pp. 177–178, our italics). They are therefore context-specific for the signaller to produce (production criterion; Scarantino 2013) and stimulus-independent for the receiver to understand (perception criterion; Scarantino 2013). This concept is a useful tool to determine potential referents of signals and, therefore, to identify superficial similarities between referential words in human language and potentially referential animal signals on a functional level. However, a comparative cognitive approach also requires establishing whether the underlying cognitive processes are similar as well. In human language, semantic reference of proper names (e.g. "Mount Everest") and other word classes is only possible in the first place because speakers and listeners have the cognitive capacity to refer to something in the world with specific communicative signals. In other words, an individual's thoughts, e.g. her intentions, or more specifically her goals, can be about external things. In this case, signals used to convey these thoughts must be about external things as well. This capacity leads some words—e.g. proper names—to be used conventionally to refer to one specific external object. Finding whether this capacity is also present in non-human animals is crucial in a comparative perspective. Signallers and receivers both have to follow such a convention in order to understand the semantic reference of a signal, which is cognitively very challenging (Lewis 1969), and most species may simply not be capable of it (Heyes 1998; Premack 2007). An individual may, for instance, have to display both metarepresentation and some form of theory of mind, i.e. knowledge about intentional states of conspecifics (Gärdenfors 2014; Sperber 2000) to take part in this convention, though a full-blown theory of mind may not be necessary (Moore 2013).

A different way to approach the notion of reference is found in the realm of pragmatics. Pragmatics is another subfield of linguistics dealing with the use of signals in certain contexts (Carnap 1942; Katz 1975, 1977; Recanati 2004). Pragmatics, as opposed to semantics, does not abstract from speakers and situations. On the contrary, it aims specifically to study the variables (who produced the signal, what situational cues lead to the production of the signal, etc.) that determine the meaning and use of words within communicative situations. Therefore, a pragmatic notion of reference focuses on the producer using a signal to refer to something within a particular situation, i.e. displaying an *act* of reference, rather than emphasizing that the signal carries itself a referential meaning. Reference as a pragmatic notion is a matter of a speaker's intention to refer (Carston 2002): what turns a signal into a referential signal is the speaker's display of this specific intentional behaviour to actively point out an entity or event to a recipient (Crockford et al. 2015).

With regard to terminology, it is important to note that "intentionality" and "intentions" are used here in the way they are used in animal behaviour research, i.e. amounting to identifying intentions with signallers displaying goal states (e.g. Schel et al. 2013), as opposed to their broader use in philosophy (a general "aboutness" of mental states, see Dennett 1983). Additionally, it appears essential to underline the difference between meaning and reference (or "referential meaning"). Here, the word "meaning" will mean that a signal/word stands for something. The word "reference" (understood as the referential meaning of a signal) is about something being *picked out* by a signal/word (Abbott 2010; Bach 1987). The difference between meaning and referential meaning therefore may amount to a difference in the intention displayed by the signaller.

A signal has only a referential meaning (i.e. refers) if the signaller has the intention to pick something out with the produced signal (Bach 1987; Carston 2002). In this paper we will argue that in order to identify such reference in animal communication, the cognitive complexity of the signaller has to be taken into account. The main cues for evaluating cognitive complexity may be found in how far

signallers take context into account in signal production. In this respect, we will rely on a pragmatic analysis—as opposed to a semantic one—of a signal's potentially referential meaning. In our analysis of reference, we will refer to pragmatics as the subfield of linguistics that does not abstract away from *speakers/signallers* producing words/signals in a specific context, as opposed to semantics (Saeed 1997), the subfield that evaluates a word's or signal's meaning only by looking at the word and the object it stands for or refers to (Bach 2006; Carnap 1942; but see Kaplan 1989; and Salmon 2005 on whether certain word classes are in fact context-independently and thus semantically referential). Our claim is thus that taking a pragmatic stance rather than using semantic reference as a theoretical basis (Scott-Phillips 2015b) serves our purpose best: we can compare the capacity of humans to refer with words with potentially referential intentions in animal signalling.

Taking this stance means introducing the question of intentionality into animal referential signalling. Whether animals are capable of participating in intentional communication is per se a highly disputed topic, most recently discussed by Scott-Phillips (2015a, in press) and Moore (in press). Grice (1957) was the first to introduce the criteria for a situation of triangular communication (i.e. communicating something to someone via a signal, Hurford 2007) to present an act of intentional communication. We adopt Moore's (in press) formulations of the two intentions involved in signal production:

(i) S utters x intending A to produce a particular response r.

and

(ii) S utters x intending A to recognize that S intends (i).

The first intention is also known as the *informative intention* involved in meaningful communication: the signaller intends to inform the audience about something. To do so, she relies on the signal x because it conveys the information via its meaning. In response, the audience must display signs of having perceived the communicated information. This response can be communicative or not. In the case of referential acts the intended information provided is the referential information. Therefore, the informative intention in our case is more precisely a referential intention (Paul 2013), a subclass of informative intentions. For example, when the signaller produces the sentence: "I decided that we will go for lunch to the Golden Dragon", she intends to inform the recipient about where they are going to have lunch by referring to the Chinese restaurant around the corner.

The second intention involved in intentional communication is labelled the *communicative intention* of the signaller. This communicative intention makes it *overt* (Sperber and Wilson 1995) to the audience that the vocalized information is important enough to extract because it was intentionally provided by the signaller. Therefore, Grice's (1957) proposal for a description of intentional communication in humans is often referred to as *ostensive* or *overtly intentional* communication (Scott-Phillips 2015a; Sperber and Wilson 1995): if the speaker did not make his intentions overt in a certain way, how should a listener come to the conclusion that the speaker intended to convey information x by uttering the meaningful signal "x", instead of "accidently" providing this information?

A major point of debate (Moore, in press; Scott-Phillips 2015a, in press) is whether current data on non-human primate signal production provide evidence for the presence of such communicative intention in these species. Scott-Phillips (2015b) claims that for most non-human primate signalling the informative intention (or in our case the intention to refer) is not made overt by the signaller but rather is covert. The signaller merely manipulates the recipient's behaviour. Moore (in press) disagrees and argues that evidence for a communicative intention is provided if eye-contact with the recipient and other elaborative behaviour are taken into account. In the criteria for referential communication provided below, we follow Moore's argument and include behaviour like persistence, checking and elaboration in our framework as evidence of a communicative intention during referential communication.

Intentionality, i.e. goal-directedness involved in potentially referential signal production, allows the signaller to flexibly control and voluntarily modify its signalling behaviour. The signaller can thus take into account different contextual cues that influence its signalling behaviour and emphasize its referential goal by producing other intentional behaviour (e.g. gazing, change of body orientation) besides the signalling. If functional reference is understood as an analogy allowing us to compare animal signals with words of human language on a structural level, then the concept does not require the signaller to signal intentionally. However, in human communication there is no *act* of reference without the signaller in fact intending to refer (Bach 1987; Carston 2002; Crockford et al. 2015). Within a comparative approach the same intention should be searched for in non-human animal communication.

In such a framework, the signaller's reference can be described in the following way:

> [Y]ou form an intention to refer to a certain thing and choose an expression [or more generally speaking: signal] whose use by you, under the circumstances,

> will enable your audience to figure out that this is what you intend to refer. (Bach 2006, p. 521; see also Crockford et al. 2015).

This kind of reference is a four-place relation between signal producer (1), signal (2), audience (3) and referent (4) in contrast to the two-place relation involved in semantic reference (i.e. the reference is determined only by the signal and the object it refers to). This implies that the signaller takes into account the situation/context in which he produces the signal: *who is my audience (3), what is happening (4), and how (2) can I (1) make it salient to my audience that it is happening.* This is what we define as the *situational factors* that constitute the reference, i.e. to what the signal is supposed to refer to. This concept of a pragmatic notion of reference can provide an indication of the complexity of the cognitive processes involved. A producer must take into account multiple cues in order for the observer to determine whether it has performed an act of reference via signal production.

Who is more important for an evaluation of potential acts of reference: the signaller, the receiver or both?

In their approach to identifying a concept of functional reference, Scarantino and Clay (2015) place a strong emphasis on the receiver's position, using this to draw conclusions about potential acts of reference and cognitive complexity, despite the fact that reference is an action of the producer of the signal (Bach 2006; Wheeler and Fischer 2015). Focusing on the receiver's responses, however, opens the door for critique: no matter how intelligently the receiver takes context into account, this may not at all be related to the signal's potential referential meaning. It could merely reflect the receiver making its decision based on attributed correlational meaning (for instance, signal *x* most of the time correlates with the presence of predator y, see Price et al. 2015; Wheeler and Fischer 2015). Using a pragmatic approach to reference, the focus must be on the mechanisms underlying the signaller's behaviour to evaluate whether it is referring to something (Scott-Phillips 2015b). However, to evaluate whether the reference is successful, and to understand what the signal in fact refers to, the receiver's response behaviour is an important clue.

Interestingly, recent studies on meaning and reference in ape gestures focus on *both* signaller's and receiver's behaviour for the evaluation of the signal's (referential) meaning (Hobaiter and Byrne 2014; Hobaiter et al. 2013; see also Roberts et al. 2013). There, the signaller must display a reaction indicating satisfaction with the receiver's response. Such an approach may help determining whether the signaller in fact intends to refer. For cases of non-intentionally meaningful signals (i.e. natural meaningful signals, Wharton 2009), this approach may, however, not be applicable, because signal production may involve a low degree of flexible and/or voluntary control and therefore may not lead the signaller to display response behaviours based on its satisfaction of the communicative situation's outcome. As a consequence, this approach could help parsing out potential cases of referential signals from non-intentionally meaningful signals.

Our proposal: a pragmatic approach to referential communication

The idea of applying pragmatic concepts rather than semantic ones is not novel in the animal communication literature. In 1961, Peter Marler pointed out that "semantics are of doubtful value in animal studies, and […] there is considerable overlap with pragmatics, even in the sphere of human language. Pragmatics on the other hand [concerns] itself with the role of […] signals in the communicatory process, a role which we seek to establish by observing and interpreting the response which they evoke in other animals" (Marler 1961, p. 299). Smith (1965, 1977) and Snowdon (1982) emphasize the same point. In subsequent decades, substantial interest has been devoted to semantic concepts (Allen 2013; Scott-Phillips and Kirby 2013) such as meaning (e.g. Cheney and Seyfarth 1988; Cheney and Seyfarth 1996; Cheney and Seyfarth 2005; Zuberbühler et al. 1999), functional reference (e.g. Evans and Evans 1999) and a "code model" of communication (e.g. Bugnyar et al. 2001). Recently, a return to a pragmatic approach has emerged in the animal communication research. This renewal of interest emphasizes the importance of contextual differences potentially influencing the meaning of a signal (Schlenker et al. 2014; Scott-Phillips 2010; but see Scott-Phillips 2015a regarding general problems involved in meaning ascriptions even by taking context into account) and how recipients infer a signal's meaning from the context (Arnold and Zuberbühler 2013; Crockford et al. 2015). Surprisingly, to date, while recent work within the pragmatic approach has focused on a vocal signal's potential meaning, the concept of reference itself has remained evaluated by a concept derived from semantics (i.e. abstracting from signallers using signals): functional reference. One possible reason is that the definition of pragmatics used in animal behaviour research (Marler 1961; Smith 1965) is not identical to the definition of pragmatics commonly applied in linguistics and appears more closely related to semantics in a linguistic sense. Pragmatics as defined in linguistics, in addition to focusing on context, underlines the importance of *speakers/*

signallers using words/signals in different ways depending on their intentions. This characterization is the essence of an act of reference in a pragmatic sense. However, to our knowledge, this focus has been absent in the vocal animal communication literature so far.

A pragmatic concept of reference, as opposed to a concept of reference derived from semantics, faces particular problems: in Bach's (2006) description of speaker's reference, the signaller is required to explicitly ascribe knowledge to his audience via an act of drawing inferences on which expression is best to use (i.e. the speaker *chooses* an expression that *enables* his audience to understand the act of reference). This type of reference may thus require a priori complex cognitive inferences: the signaller needs to evaluate the specific situation to decide whether to signal or not and must decide what signal to choose to inform the recipient and draw its attention to the object or event in question. Ultimately though, complex inferences might not be necessary: any form of communication where a signaller (a) picks out *an object in the world* with the production of a signal; (b) picks out this object *to a particular audience* and; (c) has *the goal* to pick the object out, can qualify as an act of reference. The signaller also selects its choice of signal and/or moment of signal production by taking the four situational factors into account. Finally, this choice may not be in its entirety played through each time the signaller uses the same signal type to refer; i.e. it might be ritualized (see Liebal et al. 2014 for a description and definition of ontogenetic ritualization in another communicative modality: gesturing; see Watson et al. 2015 for a potential case of ritualization of the use of a vocalization). However, even in this simplified form, the signaller must have the goal of indicating the referent every time for these cases to qualify as potential acts of signaller's reference. These considerations lead to the following definition of *signaller's reference*, applicable for animal communication:

> A vocal signal is used referentially by the signaller, if the signaller has the goal of indicating a particular object/event to an audience. The object/event is indicated in order to fulfil the goal of the producer. Furthermore, a signaller displaying an example of signaller's reference will show flexibility in signal production regarding the specific object/state of things it intends to indicate: minor situational or contextual changes (e.g. change from context of predation to non-predation contexts) may modify the goals of the producer and therefore influence signal production. In contrast a signal is not used referentially if the signaller does not actively indicate (i.e. does not have the goal/intention to point out) a specific object/event, i.e. it does not take into account the situational factors.

But how are we to determine empirically whether a signaller displays an instance of signaller's reference? Following our definition, the signaller must take into account situational factors and should react flexibly based on them, as well as infer whether and how it can achieve its goal (how to indicate the object it intends to refer to, to the conspecific). The potential inferences a signaller draws and the associations it forms help determining (a) whether there is an intended act of reference, or an intention to refer, and (b) how cognitively complex the involved mechanisms are on the signaller's side. We strongly agree here with Scarantino and Clay (2015) on the importance of integrating context into the calculation for cognitive complexity. Furthermore, by focusing on the evaluation of the signaller's cognitive mechanisms involved in the signal production, we address the issue raised by Wheeler and Fischer (2015) that any mechanism involved in signal production would be unlikely to be as cognitively complex as would be required to be labelled as an act of reference. One possibility is to assume that the more variables a signaller takes into account, the more combinatorial thinking processes it has to go through in order to decide how to react. As a consequence, the more inferences/associations the signaller has to make, the more demanding the involved cognitive processes are and the more likely a case of signaller's reference is displayed.

The following must be observed with respect to the situational factors to ascribe signaller's reference (see below for examples of behaviour linked to the factors):

1. *Regarding the signaller* How can the signaller make its potentially referential goal salient to the audience apart from the information embedded in the signal? Gaze, persistence and reinforcement of signalling, stopping when the act of reference was successful (i.e. receiver responded the intended way) and further behaviour that is required because of the audience's orientation/position shortly before signalling should be observed. For instance, if the receiver's body orientation does not allow the perception of the signaller's behaviour, behaviour should reflect the signaller's trying to change the receiver's position (e.g. trying to make the receiver turn towards the signaller).
2. *Regarding the signal* In which situations is the signal commonly produced*?* This is how a signal makes an intended act of reference salient: it is commonly produced in the context and therefore has information embedded within it that relates to the context in which it is commonly used.
3. *Regarding the audience* It should matter to the signaller who the receiver is. Therefore, audience specificity should be observed during signalling. What

is important here is the identity of the audience, for example their social relationship with the caller or their attentional or knowledge state. If the identity of the audience plays a role for signal production, the signaller may *intend* to address only specific individuals.

4. *Regarding the potential referent* What occurs in the perceivable environment shortly before and during signal production that could have caused and influenced signal production (see also: "identity vehicle cues" and "environmental vehicle cues" in Scarantino and Clay 2015).

The more factors a signaller flexibly takes into account and combines in order to signal, the more likely it refers actively via the signal. Flexibility here is used to refer to changes in a factor that cause changes in the (communicative) behaviour of the signaller. These changes have an impact on how the signaller treats/evaluates the other remaining factors. For instance chimpanzees producing snake alarm calls seem to take factor (3) into account by judging whether the audience is already aware of the presence of the snake or not (Crockford et al. 2012). Incidentally, when a signaller realizes that its previously unaware audience has come to know about the snake, it can modify its behaviour, as there is no need anymore for the signaller to make its referential goal salient (Crockford et al. 2012). In other words, the signaller can judge whether it is necessary in the specific situation to produce the signal to emphasize the presence of the snake. When the potential recipient has already seen the snake, it is not necessary anymore for the signaller to produce its call.

In summary, if we adopt our proposed theoretical framework, we may come in many cases to the conclusion that the signaller does not take into account any situational factors at all during signal production. We may then safely conclude that signalling for this particular signal type does not involve a high degree of flexibility, and as a consequence, that there is most likely no intended act of reference. The type of communication described would therefore not be comparable to reference in human words.

Alternative theoretical frameworks and how they relate to our proposal

Most of the factors we consider here have already been used in the animal communication literature, particularly to determine the presence of informative and communicative intentions in signallers in the gestural modality (Call and Tomasello 2007; Liebal et al. 2004). The situational factors and a general emphasis on reference being an intended act that we propose are similar to the treatment of potentially referential ape gestures as intentional signals (Genty and Zuberbühler 2014; Leavens et al. 1996; Liebal et al. 2014). For a gesture to be produced intentionally, the signaller must produce it in an audience-directed way (e.g. gaze alternation with the receiver, body orientation towards the receiver) and in an audience-specific way (who is the receiver?). Furthermore, Leavens et al. (2005) introduced the criteria of persistence and elaboration as indicators for intentionally produced signal: if the potentially referential goal of the signaller is not fulfilled, persistence and elaboration behaviour will be displayed to draw the attention of the receiver to the referent (Leavens et al. 2005). However, recent interpretation of potentially referential gestures as intentional acts provide criteria for the intentionality of signalling without attempting to determine the signal's referential meaning (Genty and Zuberbühler 2014; Hobaiter and Byrne 2014). The referential meaning of the gesture is determined separately via different criteria, for instance by comparing the use of the gesture with the use of the pointing gesture in humans (Leavens et al. 2005). A gesture counts as pointing (or as a so-called deictic gesture) if the individual moves its hand or arm into the direction of a target spatially distinct from another individual. In such a set up, gaze alternation between the object and the other individual, who is the potential recipient of the referential information, should be observed as well (Hobaiter et al. 2013).

Another way to apply a comparative approach for identifying referentiality in gestures is by determining whether non-human primates are capable of producing iconic gestures (Russon and Andrews 2011). Humans use iconic gestures to depict shapes of objects or movements (Cartmill et al. 2011). In great apes, iconic gestures are identified as non-vocal communication directed to another individual that "involves physically acting out a message" (Russon and Andrews 2011, p. 627). While a recent study has documented the use of an iconic beckoning gesture in bonobos (Genty and Zuberbühler 2014), reports of both iconic and deictic gestures remain extremely rare in non-human primates (Genty and Zuberbühler 2015; Hobaiter et al. 2013). Additionally, the criteria applied to identify them are not—or only with great difficulty—applicable to vocalizations, limiting the scope of their use to the gestural modality.

Regarding the vocal modality, some of the situational factors we propose were recently studied in an experimental context by Schel et al. (2013). They conducted field experiments with moving snake models to determine whether wild chimpanzees would inform others of the presence of a snake depending on the knowledge state of the audience. Schel and colleagues predicted that if this

was the case, individuals' potential snake alarm calling would be dependent on the audiences' gazing towards the snake. Signallers were expected to display gaze alternation between the audience and the snake and infer from the situation whether signalling, i.e. giving information about the presence of the snake, was still necessary. In their study, Schel and colleagues emphasized how situational changes should influence intentional signal production, studying in particular two sets of criteria. Firstly, they studied whether an audience was present or not and analysed its composition, particularly whether friends or dominant members were in the party. These points correspond to our factor (3). Secondly, they looked for audience checking and gaze alternation between recipient and snake as well as evidence of persistence behaviour until everyone was informed of the presence of the snake. This corresponds to the group of behaviours presented in our factor (1).

The two criteria used by Schel et al. (2013) focus on finding evidence that the signaller produced a signal intentionally (i.e. signals produced to fulfil a goal). Because we are interested in a specific informative intention—to refer with a signal that does help pick out the referent—we add to Schel et al.'s criteria our factors (2) and (4). These factors focus on behaviour by the signaller that helps pointing out the referent to a recipient in a specific situation. Factor (2) is an approach to determine the information embedded in the signal. Though Schel and colleagues label signals as snake alarm calls because they are commonly produced in snake predation contexts, they do not list the information a call provides as a criterion to look at. This is important though for potentially referential communication, where calls could have certain information embedded but used in different contexts. Factor (4) focuses on situational changes, which are important when looking for the intended referent. Questions that can be studied via this factor are for instance: what is the signal referring to, is the referent (still) salient to the recipient; and does the signaller adjust its behaviour according to changes in its immediate environment?

In summary, our proposal attempts to merge both features of intentionality and referentiality by providing a fixed, universal framework applicable in *both the gestural and vocal modalities*, answering to a recent concern in the literature (Genty et al. 2014; Leavens et al. 2010; Liebal et al. 2014). In this respect, both deictic and iconic gestures can be identified as referential within our framework. In the following, we illustrate how it allows identifying acts of reference in the vocal modality with an example taken from previous research on chimpanzee "travel hoo" vocalizations. We also provide an analysis of a deictic behaviour in the gestural modality.

"Travel hoo" vocalizations in chimpanzees and deictic behaviour in crows: an application of our theoretical framework

"Travel hoos" are short-range vocalizations most commonly produced in order to recruit conspecifics for joint travel (Gruber and Zuberbühler 2013). In addition, they may be produced by individuals who start following a travelling party, potentially to indicate their joining in. For simplicity's sake, we will focus here only on the first function of the vocalization.

The collected observational data showed that:

1. In cases of unsuccessful travel initiations, signallers displayed signs of persistence in the form of repeated travel hoo production and checking (i.e. the signaller turns its body 90°–180° towards the receiver). In cases of successful travel initiations the signaller also gazed backwards towards the receiver, perhaps to take into account the receiver's position.
2. The travel hoo vocalization was produced in travel initiation contexts.
3. Audience specificity seemed to be involved in signal production; i.e. the signallers preferentially produced hoos in the presence of allies.
4. Situations in which travel hoos were produced followed a simple behavioural formula: first the signaller started staring towards the direction of travel for some seconds, then produced the travel hoos, started the travel bout by walking towards the direction it was glancing at, and finally waited for potentially recruited individuals, while checking for its audience by gazing backwards in their direction. The reference here might therefore have been towards an intended travel event.

Such a successful, common travel initiation seems to show good evidence of being a case of signaller's reference. Observational data show that travel initiations are more likely to be successful when travel hoos are produced; thus, individuals with the goal of travelling and who intend to make this travel intention salient to conspecifics may produce the vocalization to make the act of reference successful. Anecdotal observations also show that there are other ways to make the potential travel partner aware of the future travel event in joint travel scenarios. For instance, exaggerated movements, branch shaking or pant-hoots seem to be used by individuals to make potential travel partners focus on them, so that they join the travel when the individual starts travelling (Sievers, personal observations). However, none of these signals—pant-hoots, branch shaking and exaggerated movements—appear to have meanings specifically correlated with travel. They function as attention getters, and if the attention is obtained, a travel

hoo that means "let's travel" may not be necessary anymore. Under the hypothesis that the travel hoo is an intentionally referential signal, future research must therefore show that the travel hoo is in fact produced only when it is necessary for the signaller to produce it, i.e. when it is necessary to point out the travel intent. Indicators for this could be, for instance, that the recipient is not focused on the signaller, does not check upon the signaller or is focused on a different individual than the signaller.

The scenario above also illustrates how the signaller might "choose" this particular signal—the "travel hoo"—to make the reference salient to the intended receiver, a close ally. The signaller takes into account who it wants to make the reference salient to, checks whether it is indeed salient for the recipient, and appears to be using the signal specifically to ensure it is salient to the recipient. Although it is ultimately impossible to check whether the signallers really intended to recruit particular individuals by intentionally pointing the travel out to them, one important observation is that the signaller could also choose not to produce a "travel hoo" and still begin travelling. A silent departure may make potential joint travel less salient to conspecifics, and these situations occurred primarily when no ally was in the party. All in all, this suggests that chimpanzee signallers can flexibly take into account contextual factors.

Furthermore, even in the case of a cognitively simpler interpretation of the signaller merely trying to achieve its goal of travelling instead of actively referring to the future travel event, the following is important to note: with all four situational factors occurring in correlation—(1) the signaller persists, checks with a specific recipient (3), gazes into the travel direction (4), while producing a signal, whose meaning is correlated with travel (2)—at the very least the signaller appears to *insist on its goal* by making the potential travel event salient to the recipient via external cues (signalling, gazing, etc.).

Our theoretical framework, applied above to situations of travel hoo vocalizations, can be adapted to other communicative means in other species. For instance, deictic behaviour has been described in a number of species in addition to apes, such as corvids (*Corvus corax*, Pika and Bugnyar 2011) or domestic dogs (*Canis lupus familiaris*, Savalli et al. 2014). We apply here our framework to the corvid example. In this study, individuals, studied in pairs, displayed behaviours such as "showing" or "offering" non-edible items to each other. They displayed response waiting after displaying these behaviours, which were more often produced when the recipient was attending to the signaller. In our framework, both factors (1) and (4) appear therefore to be fulfilled. In regard to factor (2), the "showing" and "offering" behaviours are described as "object-oriented" behaviours (p. 2). Because the behaviours do not appear tightly correlated with the non-feeding context, the information embedded in the signals may not go beyond a message along the lines of "look here". Finally, we cannot assess factor (3), audience specificity, because of the study design. More data are therefore necessary to assess whether the "showing" and "offering" gestures in corvids would qualify as referential in our framework, particularly with respect to context and audience specificity.

Conclusion: What does it take to refer?

As Wheeler and Fischer (2012, 2015) and Scarantino and Clay (Scarantino 2013; Scarantino and Clay 2015) have gone through in detail, most animal vocalizations do not fit into the original definition of functional reference (Macedonia and Evans 1993). In fact, even the paradigmatic case of a functionally referential call system, vervet monkey (*Chlorocebus pygerythrus*) alarm calls, on re-analysis, may not meet the criteria for functional reference, with context playing a bigger role than previously allowed (Price et al. 2015). While Wheeler and Fischer (2012) have proposed abandoning the concept altogether, Scarantino and Clay have proposed extending its definition to better take into account contextual cues (Scarantino and Clay 2015). However, the concept of functional reference in its original (Macedonia and Evans 1993) and updated version (Scarantino 2013; Scarantino and Clay 2015) may only present a simplification of what actually takes place during communication between animals, just as semantics arguably abstracts from what takes place during communication between humans (Carnap 1942; Wilson and Sperber 1981). This reasoning turns the concept of functional reference into a mere tool to determine potential referents of signals, but cannot determine whether the signal itself in fact refers. Such a tool though does not need to be abandoned if it fulfils its function: to determine what the signal in most instances of use will refer to (Townsend and Manser 2013). As such, we believe that the concept of functional reference, as amended by Scarantino and Clay (2015), remains useful in the study of animal communication.

If, however, we are interested in a comparison of referentiality in human and non-human communication based on the cognitive processes underlying signal production, the notion of functional reference does not appear to be informative (Wheeler and Fischer 2015). To evaluate whether non-human communication can compare to human reference, we have to turn to actual situations of signalling and adopt a pragmatic approach allowing us to identify "acts of reference". To do so, in this article, we have proposed the concept of *signaller's reference*, which we have defined in relation to a pragmatic approach developed

in the field of linguistics. Here the focus is put on the signaller, and how it intentionally produces its referential signal to modify its audience's behaviour. Accordingly, to evaluate the flexibility and cognitive complexity involved in the potential act of reference, it is necessary to study whether the signaller actively indicates an entity or event in the external world to an audience. This amounts to studying whether the signaller has the goal to refer the recipient to this particular entity/event. This approach has already been in use for some part in gestural signalling work, though a universal framework for identifying referential signalling in both the gestural and vocal modalities is still lacking (Liebal et al. 2014). We therefore believe that our proposal to study signaller's reference is also a step towards a unifying framework analysing animal referential communication as one phenomenon rather than as the sum of its modalities.

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