

2 **Reference in human and non-human primate communication:**  
3 **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

**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 Sidel 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

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64 criteria for intentionality and referentiality. In doing so, we  
 65 aspire to provide a fixed, universal framework applicable to  
 66 a specific situation of signal production, independent of the  
 67 communicative modality. This framework will be based on  
 68 the assumption that in order to refer with signals the way  
 69 humans do, the signal producer must have an *intention* to  
 70 refer. This intention to refer might be present if the sig-  
 71 naller flexibly produces the signal, depending on contextual  
 72 changes. We first summarize the conceptual framework,  
 73 mainly inspired from semantics, which has supported pre-  
 74 vious analyses of animal referential signalling. We then  
 75 present a framework inspired by linguistic pragmatics to  
 76 analyse a type of reference that we name *signaller's ref-*  
 77 *erence*, described in the human literature but absent in the  
 78 animal literature. Finally, we exemplify this framework  
 79 with vocalizations produced by wild chimpanzees during  
 80 travel.

## 81 **Why is animal reference important and what** 82 **notion of reference are we actually looking for?**

83 Up to now, discussions about referential animal signals  
 84 have been dominated by the concept of functional refer-  
 85 ence (Wheeler and Fischer 2012). This concept appears to  
 86 be related to semantic reference of human words: it  
 87 abstracts from signallers and attempts to identify signals  
 88 and their referents. Signals are functionally referential if  
 89 they are “elicited by a special class of stimuli and capable  
 90 of causing behaviours adaptive to such stimuli *in absence*  
 91 *of contextual cues*” (Macedonia and Evans 1993:  
 92 pp. 177–178, our italics). They are therefore context-  
 93 specific for the signaller to produce (production criterion;  
 94 Scarantino 2013) and stimulus-independent for the receiver  
 95 to understand (perception criterion; Scarantino 2013). This  
 96 concept is a useful tool to determine potential referents of  
 97 signals and, therefore, to identify superficial similarities  
 98 between referential words in human language and poten-  
 99 tially referential animal signals on a functional level.  
 100 However, a comparative cognitive approach also requires  
 101 establishing whether the underlying cognitive processes are  
 102 similar as well. In human language, semantic reference of  
 103 proper names (e.g. “Mount Everest”) and other word  
 104 classes is only possible in the first place because speakers  
 105 and listeners have the cognitive capacity to refer to  
 106 something in the world with specific communicative sig-  
 107 nals. In other words, an individual’s thoughts, e.g. her  
 108 intentions, or more specifically her goals, can be about  
 109 external things. In this case, signals used to convey these  
 110 thoughts must be about external things as well. This  
 111 capacity leads some words—e.g. proper names—to be used  
 112 conventionally to refer to one specific external object.  
 113 Finding whether this capacity is also present in non-human

animals is crucial in a comparative perspective. Signallers 114  
 and receivers both have to follow such a convention in 115  
 order to understand the semantic reference of a signal, 116  
 which is cognitively very challenging (Lewis 1969), and 117  
 most species may simply not be capable of it (Heyes 1998; 118  
 Premack 2007). An individual may, for instance, have to 119  
 display both metarepresentation and some form of theory 120  
 of mind, i.e. knowledge about intentional states of con- 121  
 specifics (Gärdenfors 2014; Sperber 2000) to take part in 122  
 this convention, though a full-blown theory of mind may 123  
 not be necessary (Moore 2013). 124

A different way to approach the notion of reference is 125  
 found in the realm of pragmatics. Pragmatics is another 126  
 subfield of linguistics dealing with the use of signals in 127  
 certain contexts (Carnap 1942; Katz 1975, 1977; Recanati 128  
 2004). Pragmatics, as opposed to semantics, does not 129  
 abstract from speakers and situations. On the contrary, it 130  
 aims specifically to study the variables (who produced the 131  
 signal, what situational cues lead to the production of the 132  
 signal, etc.) that determine the meaning and use of words 133  
 within communicative situations. Therefore, a pragmatic 134  
 notion of reference focuses on the producer using a signal 135  
 to refer to something within a particular situation, i.e. 136  
 displaying an *act* of reference, rather than emphasizing that 137  
 the signal carries itself a referential meaning. Reference as 138  
 a pragmatic notion is a matter of a speaker’s intention to 139  
 refer (Carston 2002): what turns a signal into a referential 140  
 signal is the speaker’s display of this specific intentional 141  
 behaviour to actively point out an entity or event to a 142  
 recipient (Crockford et al. 2015). 143

With regard to terminology, it is important to note that 144  
 “intentionality” and “intentions” are used here in the way 145  
 they are used in animal behaviour research, i.e. amounting 146  
 to identifying intentions with signallers displaying goal 147  
 states (e.g. Schel et al. 2013), as opposed to their broader 148  
 use in philosophy (a general “aboutness” of mental states, 149  
 see Dennett 1983). Additionally, it appears essential to 150  
 underline the difference between meaning and reference 151  
 (or “referential meaning”). Here, the word “meaning” will 152  
 mean that a signal/word stands for something. The word 153  
 “reference” (understood as the referential meaning of a 154  
 signal) is about something being *picked out* by a sig- 155  
 nal/word (Abbott 2010; Bach 1987). The difference 156  
 between meaning and referential meaning therefore may 157  
 amount to a difference in the intention displayed by the 158  
 signaller. 159

A signal has only a referential meaning (i.e. refers) if the 160  
 signaller has the intention to pick something out with the 161  
 produced signal (Bach 1987; Carston 2002). In this paper 162  
 we will argue that in order to identify such reference in 163  
 animal communication, the cognitive complexity of the 164  
 signaller has to be taken into account. The main cues for 165  
 evaluating cognitive complexity may be found in how far 166

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

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

- 196 (i) S utters  $x$  intending A to produce a particular  
 197 response  $r$ .
- 198 and
- 199 (ii) S utters  $x$  intending A to recognize that S intends  
 200 (i).

201 The first intention is also known as the *informative*  
 202 *intention* involved in meaningful communication: the sig-  
 203 naller intends to inform the audience about something. To  
 204 do so, she relies on the signal  $x$  because it conveys the  
 205 information via its meaning. In response, the audience must  
 206 display signs of having perceived the communicated  
 207 information. This response can be communicative or not.  
 208 In the case of referential acts the intended information  
 209 provided is the referential information. Therefore, the  
 210 informative intention in our case is more precisely a refer-  
 211 ential intention (Paul 2013), a subclass of informative  
 212 intentions. For example, when the signaller produces the  
 213 sentence: “I decided that we will go for lunch to the  
 214 Golden Dragon”, she intends to inform the recipient about  
 215 where they are going to have lunch by referring to the  
 216 Chinese restaurant around the corner.

217 The second intention involved in intentional communi-  
 218 cation is labelled the *communicative intention* of the sig-  
 219 naller. This communicative intention makes it *overt*  
 220 (Sperber and Wilson 1995) to the audience that the  
 221 vocalized information is important enough to extract  
 222 because it was intentionally provided by the signaller.  
 223 Therefore, Grice’s (1957) proposal for a description of  
 224 intentional communication in humans is often referred to as  
 225 *ostensive* or *overtly intentional* communication (Scott-  
 226 Phillips 2015a; Sperber and Wilson 1995): if the speaker  
 227 did not make his intentions overt in a certain way, how  
 228 should a listener come to the conclusion that the speaker  
 229 intended to convey information  $x$  by uttering the mean-  
 230 ingful signal “ $x$ ”, instead of “accidentally” providing this  
 231 information?

232 A major point of debate (Moore, in press; Scott-Phillips  
 233 2015a, in press) is whether current data on non-human pri-  
 234 mate signal production provide evidence for the presence of  
 235 such communicative intention in these species. Scott-Phil-  
 236 lips (2015b) claims that for most non-human primate sig-  
 237 nalling the informative intention (or in our case the intention  
 238 to refer) is not made overt by the signaller but rather is covert.  
 239 The signaller merely manipulates the recipient’s behaviour.  
 240 Moore (in press) disagrees and argues that evidence for a  
 241 communicative intention is provided if eye-contact with the  
 242 recipient and other elaborative behaviour are taken into  
 243 account. In the criteria for referential communication pro-  
 244 vided below, we follow Moore’s argument and include  
 245 behaviour like persistence, checking and elaboration in our  
 246 framework as evidence of a communicative intention during  
 247 referential communication.

248 Intentionality, i.e. goal-directedness involved in poten-  
 249 tially referential signal production, allows the signaller to  
 250 flexibly control and voluntarily modify its signalling  
 251 behaviour. The signaller can thus take into account dif-  
 252 ferent contextual cues that influence its signalling behav-  
 253 iour and emphasize its referential goal by producing other  
 254 intentional behaviour (e.g. gazing, change of body orien-  
 255 tation) besides the signalling. If functional reference is  
 256 understood as an analogy allowing us to compare animal  
 257 signals with words of human language on a structural level,  
 258 then the concept does not require the signaller to signal  
 259 intentionally. However, in human communication there is  
 260 no *act* of reference without the signaller in fact intending to  
 261 refer (Bach 1987; Carston 2002; Crockford et al. 2015).  
 262 Within a comparative approach the same intention should  
 263 be searched for in non-human animal communication.

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

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

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

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

## 288 Who is more important for an evaluation 289 of potential acts of reference: the signaller, 290 the receiver or both?

291 In their approach to identifying a concept of functional  
292 reference, Scarantino and Clay (2015) place a strong  
293 emphasis on the receiver's position, using this to draw  
294 conclusions about potential acts of reference and cognitive  
295 complexity, despite the fact that reference is an action of  
296 the producer of the signal (Bach 2006; Wheeler and Fischer  
297 2015). Focusing on the receiver's responses, however,  
298 opens the door for critique: no matter how intelligently the  
299 receiver takes context into account, this may not at all be  
300 related to the signal's potential referential meaning. It  
301 could merely reflect the receiver making its decision based  
302 on attributed correlational meaning (for instance, signal  
303  $x$  most of the time correlates with the presence of predator  
304  $y$ , see Price et al. 2015; Wheeler and Fischer 2015). Using  
305 a pragmatic approach to reference, the focus must be on the  
306 mechanisms underlying the signaller's behaviour to evalu-  
307 ate whether it is referring to something (Scott-Phillips  
308 2015b). However, to evaluate whether the reference is  
309 successful, and to understand what the signal in fact refers  
310 to, the receiver's response behaviour is an important clue.

311 Interestingly, recent studies on meaning and reference in  
312 ape gestures focus on *both* signaller's and receiver's  
313 behaviour for the evaluation of the signal's (referential)  
314 meaning (Hobaiter and Byrne 2014; Hobaiter et al. 2013;  
315 see also Roberts et al. 2013). There, the signaller must  
316 display a reaction indicating satisfaction with the receiver's  
317 response. Such an approach may help determining whether

the signaller in fact intends to refer. For cases of non- 318  
intentionally meaningful signals (i.e. natural meaningful 319  
signals, Wharton 2009), this approach may, however, not 320  
be applicable, because signal production may involve a low 321  
degree of flexible and/or voluntary control and therefore 322  
may not lead the signaller to display response behaviours 323  
based on its satisfaction of the communicative situation's 324  
outcome. As a consequence, this approach could help 325  
parsing out potential cases of referential signals from non- 326  
intentionally meaningful signals. 327

## Our proposal: a pragmatic approach to referential 328 communication 329

The idea of applying pragmatic concepts rather than 330  
semantic ones is not novel in the animal communication 331  
literature. In 1961, Peter Marler pointed out that "seman- 332  
tics are of doubtful value in animal studies, and [...] there 333  
is considerable overlap with pragmatics, even in the sphere 334  
of human language. Pragmatics on the other hand [con- 335  
cerns] itself with the role of [...] signals in the communi- 336  
catory process, a role which we seek to establish by 337  
observing and interpreting the response which they evoke 338  
in other animals" (Marler 1961, p. 299). Smith (1965, 339  
1977) and Snowdon (1982) emphasize the same point. In 340  
subsequent decades, substantial interest has been devoted 341  
to semantic concepts (Allen 2013; Scott-Phillips and Kirby 342  
2013) such as meaning (e.g. Cheney and Seyfarth 1988; 343  
Cheney and Seyfarth 1996; Cheney and Seyfarth 2005; 344  
Zuberbühler et al. 1999), functional reference (e.g. Evans 345  
and Evans 1999) and a "code model" of communication 346  
(e.g. Bugnyar et al. 2001). Recently, a return to a pragmatic 347  
approach has emerged in the animal communication 348  
research. This renewal of interest emphasizes the impor- 349  
tance of contextual differences potentially influencing the 350  
meaning of a signal (Schlenker et al. 2014; Scott-Phillips 351  
2010; but see Scott-Phillips 2015a regarding general 352  
problems involved in meaning ascriptions even by taking 353  
context into account) and how recipients infer a signal's 354  
meaning from the context (Arnold and Zuberbühler 2013; 355  
Crockford et al. 2015). Surprisingly, to date, while recent 356  
work within the pragmatic approach has focused on a vocal 357  
signal's potential meaning, the concept of reference itself 358  
has remained evaluated by a concept derived from 359  
semantics (i.e. abstracting from signallers using signals): 360  
functional reference. One possible reason is that the defi- 361  
nition of pragmatics used in animal behaviour research 362  
(Marler 1961; Smith 1965) is not identical to the definition 363  
of pragmatics commonly applied in linguistics and appears 364  
more closely related to semantics in a linguistic sense. 365  
Pragmatics as defined in linguistics, in addition to focusing 366  
on context, underlines the importance of *speakers'* 367

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

373 A pragmatic concept of reference, as opposed to a concept  
 374 of reference derived from semantics, faces particular prob-  
 375 lems: in Bach's (2006) description of speaker's reference,  
 376 the signaller is required to explicitly ascribe knowledge to his  
 377 audience via an act of drawing inferences on which expres-  
 378 sion is best to use (i.e. the speaker *chooses* an expression that  
 379 *enables* his audience to understand the act of reference). This  
 380 type of reference may thus require a priori complex cognitive  
 381 inferences: the signaller needs to evaluate the specific situ-  
 382 ation to decide whether to signal or not and must decide what  
 383 signal to choose to inform the recipient and draw its attention  
 384 to the object or event in question. Ultimately though, com-  
 385 plex inferences might not be necessary: any form of com-  
 386 munication where a signaller (a) picks out *an object in the*  
 387 *world* with the production of a signal; (b) picks out this object  
 388 *to a particular audience* and; (c) has *the goal* to pick the  
 389 object out, can qualify as an act of reference. The signaller  
 390 also selects its choice of signal and/or moment of signal  
 391 production by taking the four situational factors into account.  
 392 Finally, this choice may not be in its entirety played through  
 393 each time the signaller uses the same signal type to refer; i.e.  
 394 it might be ritualized (see Liebal et al. 2014 for a description  
 395 and definition of ontogenetic ritualization in another com-  
 396 municative modality: gesturing; see Watson et al. 2015 for a  
 397 potential case of ritualization of the use of a vocalization).  
 398 However, even in this simplified form, the signaller must  
 399 have the goal of indicating the referent every time for these  
 400 cases to qualify as potential acts of signaller's reference.  
 401 These considerations lead to the following definition of  
 402 *signaller's reference*, applicable for animal communication:

403 A vocal signal is used referentially by the signaller, if  
 404 the signaller has the goal of indicating a particular  
 405 object/event to an audience. The object/event is  
 406 indicated in order to fulfil the goal of the producer.  
 407 Furthermore, a signaller displaying an example of  
 408 signaller's reference will show flexibility in signal  
 409 production regarding the specific object/state of  
 410 things it intends to indicate: minor situational or  
 411 contextual changes (e.g. change from context of  
 412 predation to non-predation contexts) may modify the  
 413 goals of the producer and therefore influence signal  
 414 production. In contrast a signal is not used referen-  
 415 tially if the signaller does not actively indicate (i.e.  
 416 does not have the goal/intention to point out) a  
 417 specific object/event, i.e. it does not take into account  
 418 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 Scar-  
 antino and Clay (2015) on the importance of integrating  
 context into the calculation for cognitive complexity.  
 Furthermore, by focusing on the evaluation of the sig-  
 naller's cognitive mechanisms involved in the signal pro-  
 duction, 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/as-  
 sociations 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/posi-  
 tion 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

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

476 4. *Regarding the potential referent* What occurs in the  
477 perceivable environment shortly before and during  
478 signal production that could have caused and influ-  
479 enced signal production (see also: “identity vehicle  
480 cues” and “environmental vehicle cues” in Scarantino  
481 and Clay 2015).

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

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

## 510 **Alternative theoretical frameworks and how they** 511 **relate to our proposal**

512 Most of the factors we consider here have already been  
513 used in the animal communication literature, particularly to  
514 determine the presence of informative and communicative  
515 intentions in signallers in the gestural modality (Call and  
516 Tomasello 2007; Liebal et al. 2004). The situational factors  
517 and a general emphasis on reference being an intended act

518 that we propose are similar to the treatment of potentially  
519 referential ape gestures as intentional signals (Genty and  
520 Zuberbühler 2014; Leavens et al. 1996; Liebal et al. 2014).  
521 For a gesture to be produced intentionally, the signaller  
522 must produce it in an audience-directed way (e.g. gaze  
523 alternation with the receiver, body orientation towards the  
524 receiver) and in an audience-specific way (who is the  
525 receiver?). Furthermore, Leavens et al. (2005) introduced  
526 the criteria of persistence and elaboration as indicators for  
527 intentionally produced signal: if the potentially referential  
528 goal of the signaller is not fulfilled, persistence and elab-  
529 oration behaviour will be displayed to draw the attention of  
530 the receiver to the referent (Leavens et al. 2005). However,  
531 recent interpretation of potentially referential gestures as  
532 intentional acts provide criteria for the intentionality of  
533 signalling without attempting to determine the signal’s  
534 referential meaning (Genty and Zuberbühler 2014; Hobaiter  
535 and Byrne 2014). The referential meaning of the gesture  
536 is determined separately via different criteria, for instance  
537 by comparing the use of the gesture with the use of the  
538 pointing gesture in humans (Leavens et al. 2005). A gesture  
539 counts as pointing (or as a so-called deictic gesture) if the  
540 individual moves its hand or arm into the direction of a  
541 target spatially distinct from another individual. In such a  
542 set up, gaze alternation between the object and the other  
543 individual, who is the potential recipient of the referential  
544 information, should be observed as well (Hobaiter et al.  
545 2013).

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

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

570 was the case, individuals' potential snake alarm calling  
571 would be dependent on the audiences' gazing towards the  
572 snake. Signallers were expected to display gaze alternation  
573 between the audience and the snake and infer from the  
574 situation whether signalling, i.e. giving information about  
575 the presence of the snake, was still necessary. In their  
576 study, Schel and colleagues emphasized how situational  
577 changes should influence intentional signal production,  
578 studying in particular two sets of criteria. Firstly, they  
579 studied whether an audience was present or not and anal-  
580 ysed its composition, particularly whether friends or  
581 dominant members were in the party. These points corre-  
582 spond to our factor (3). Secondly, they looked for audience  
583 checking and gaze alternation between recipient and snake  
584 as well as evidence of persistence behaviour until everyone  
585 was informed of the presence of the snake. This corre-  
586 sponds to the group of behaviours presented in our factor  
587 (1).

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

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

## 622 "Travel hoo" vocalizations in chimpanzees 623 and deictic behaviour in crows: an application 624 of our theoretical framework

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

632 The collected observational data showed that:

- 633 1. In cases of unsuccessful travel initiations, signallers  
634 displayed signs of persistence in the form of repeated  
635 travel hoo production and checking (i.e. the signaller  
636 turns its body 90°–180° towards the receiver). In cases  
637 of successful travel initiations the signaller also gazed  
638 backwards towards the receiver, perhaps to take into  
639 account the receiver's position.
- 640 2. The travel hoo vocalization was produced in travel  
641 initiation contexts.
- 642 3. Audience specificity seemed to be involved in signal  
643 production; i.e. the signallers preferentially produced  
644 hoo"s in the presence of allies.
- 645 4. Situations in which travel hoo"s were produced fol-  
646 lowed a simple behavioural formula: first the signaller  
647 started staring towards the direction of travel for some  
648 seconds, then produced the travel hoo"s, started the  
649 travel bout by walking towards the direction it was  
650 glancing at, and finally waited for potentially recruited  
651 individuals, while checking for its audience by gazing  
652 backwards in their direction. The reference here might  
653 therefore have been towards an intended travel event.

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

672 hoo that means “let’s travel” may not be necessary any-  
 673 more. Under the hypothesis that the travel hoo is an  
 674 intentionally referential signal, future research must  
 675 therefore show that the travel hoo is in fact produced only  
 676 when it is necessary for the signaller to produce it, i.e.  
 677 when it is necessary to point out the travel intent. Indicators  
 678 for this could be, for instance, that the recipient is not  
 679 focused on the signaller, does not check upon the signaller  
 680 or is focused on a different individual than the signaller.

681 The scenario above also illustrates how the signaller  
 682 might “choose” this particular signal—the “travel hoo”—  
 683 to make the reference salient to the intended receiver, a  
 684 close ally. The signaller takes into account who it wants to  
 685 make the reference salient to, checks whether it is indeed  
 686 salient for the recipient, and appears to be using the signal  
 687 specifically to ensure it is salient to the recipient. Although  
 688 it is ultimately impossible to check whether the signallers  
 689 really intended to recruit particular individuals by inten-  
 690 tionally pointing the travel out to them, one important  
 691 observation is that the signaller could also choose not to  
 692 produce a “travel hoo” and still begin travelling. A silent  
 693 departure may make potential joint travel less salient to  
 694 conspecifics, and these situations occurred primarily when  
 695 no ally was in the party. All in all, this suggests that  
 696 chimpanzee signallers can flexibly take into account con-  
 697 textual factors.

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

709 Our theoretical framework, applied above to situations  
 710 of travel hoo vocalizations, can be adapted to other com-  
 711 municative means in other species. For instance, deictic  
 712 behaviour has been described in a number of species in  
 713 addition to apes, such as corvids (*Corvus corax*, Pika and  
 714 Bugnyar 2011) or domestic dogs (*Canis lupus familiaris*,  
 715 Savalli et al. 2014). We apply here our framework to the  
 716 corvid example. In this study, individuals, studied in pairs,  
 717 displayed behaviours such as “showing” or “offering”  
 718 non-edible items to each other. They displayed response  
 719 waiting after displaying these behaviours, which were more  
 720 often produced when the recipient was attending to the  
 721 signaller. In our framework, both factors (1) and (4) appear  
 722 therefore to be fulfilled. In regard to factor (2), the  
 723 “showing” and “offering” behaviours are described as  
 724 “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 (Mace-  
 donia 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 (Scar-  
 antino 2013; Scarantino and Clay 2015) may only present a  
 simplification of what actually takes place during com-  
 munication 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 refer-  
 ence, as amended by Scarantino and Clay (2015), remains  
 useful in the study of animal communication.

If, however, we are interested in a comparison of ref-  
 erentiality 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



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

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