

1 Every product needs a process: Unpacking joint commitment as a process across species

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10 11 12 13 **Abstract**

14 Joint commitment, the feeling of mutual obligation binding participants in a joint action, is
15 typically conceptualized as arising by the expression and acceptance of a promise. This account limits
16 the possibilities of investigating fledgling forms of joint commitment in actors linguistically less well-
17 endowed than adult humans. The feeling of mutual obligation is one aspect of joint commitment (the
18 *product*), which emerges from a *process* of signal exchange. It is gradual rather than binary; feelings
19 of mutual obligation can vary in strength according to how explicit commitments are perceived to be.
20 Joint commitment processes are more complex than simple promising, in at least three ways. They are
21 affected by prior joint actions, which create precedents and conventions that can be embodied in
22 material arrangements of institutions. Joint commitment processes also arise as solutions to generic
23 coordination problems related to opening up, maintaining and closing down joint actions. Finally,
24 during joint actions, additional, specific commitments are made piecemeal. These stack up over time
25 and persist, making it difficult for participants to disengage from joint actions. These
26 complexifications open up new perspectives for assessing joint commitment across species.

1. Joint action and joint commitments in human and nonhuman cooperation

Individuals in many species cooperate to improve their outcomes (Smith et al., 2012; Smith et al., 1981). But only humans are capable of participating in *joint actions* (Clark, 1996), assembling individual efforts into a coordinated whole on the basis of shared goals (Call, 2009; Tomasello & Carpenter, 2007) and a sense of joint commitment (Gilbert, 1990, 2014). Joint actions vary widely in their complexity, spatiotemporal extension, and participants involved. Paddling a two-person canoe and gossiping with a colleague over coffee are joint actions, but so are building a ziggurat, shepherding a host of soldiers and elephants over the Alps to attack Rome or putting a human being on the moon. Much research has attempted to describe the uniquely human abilities and motivations that enable us to engage in joint actions (Levinson, 2006).

One important feature of human joint action is *joint commitment*, the sense of obligation participants feel towards each other. Joint commitment is the “glue” holding joint actions together (Carpenter, 2009) in the face of alternative actions tempting them to defect. Beyond single joint actions, joint commitment is important in maintaining personal (Wieselquist et al., 1999) or professional relationships (Meyer & Allen, 1991) in the modern world. Indeed, many joint actions take place within long-term social relations, and the commitment to the relationship facilitates the establishment of commitments to these joint actions (whereas the completion of the actions strengthens the relationship). Joint commitment is thus a central aspect of human social life that develops early (around 3 years old; Gräfenhain et al., 2009). Beyond the psychological and relational aspects described here, joint commitment underlies many economic (Schelling, 2007), religious (Irons, 2001), political (Gilbert, 2014) and legal (Bolton & Dewatripont, 2005) phenomena.

The fundamental nature of joint commitment to human social life begs the question of how it may have evolved in the primate and human lineage. It is here that controversy is to be found. Prominent accounts of joint action emanating from philosophy (Bratman, 1993; Gilbert, 2017) invoke high-level cognitive processes involving recursive attributions of intentionality (Tollefsen & Dale, 2012). In brief, joint commitments typically arise through the production of speech acts (Searle, 1990) like promises (but also threats, Schelling, 2007) to perform particular actions. These speech acts create a reciprocal sense of obligation among participants. In these accounts, joint commitment is a binary phenomenon – a promise (*I’ll buy tickets for both of us*) and its acceptance (*Great, thanks!*) instantaneously creating common ground about the nature and extent of the commitment.

These accounts of joint commitment have been foundational (Knoblich, Butterfill, & Sebanz, 2011), guiding research in the linguistic coordination of joint action (Clark, 1996), but also on its ontogenetic and phylogenetic roots (Call, 2009). However, their treatment of the sense of obligation as a binary phenomenon leaves little room for understanding how it may have evolved from earlier forms of communication and cognition. Of course, any rudimentary sense of commitment in animals cannot match that in humans. At the very least, humans’ cooperative nature, their social cognition, their capacities for symbolic communication and the institutionalized nature of their social life have transformed joint commitment phenomena (Tomasello, 2010). However, such capacities did not appear *ex nihilo*, and many have proposed gradualist or naturalistic accounts of the evolution of the human arsenal of cognitive and motivational abilities for social interaction through the primate lineage (e.g., Levinson, this volume; Levinson & Holler, 2014; Townsend et al., 2017). But these accounts have not really focused on issues related to joint commitment. In this paper, then, we pull these threads and others together to build a conceptual framework for research exploring joint commitment using criteria appropriate for both humans and animals.

Such a framework needs to build on a richer understanding of joint commitment. As a first step (Section 2) we revisit a distinction (Gilbert, 2017) between joint commitment as product and as

74 process. Joint commitment-as-product refers to the sense of commitment that participants feel, that is
75 the feeling of normative obligation to each other and to completing the joint action. Joint commitment-
76 as-process refers to the exchange of signals between participants that creates their sense of
77 commitment. That is, the sense of commitment (the product) emerges from the signal exchange (the
78 process). Research has tended to focus on joint commitment-as-product, but neglected joint
79 commitment-as-process.

80 Second, the sense of commitment is not necessarily an all-or-nothing experience. It can be gradual,
81 with mutually known commitment as one end of a continuum of certainty (Bonalumi, Michael, &
82 Heintz, 2021). In other words, the possibility of implicit commitments established by other means
83 besides explicit speech acts like promises, needs to be recognized (Section 3).

84 A third step entails unpacking the complexity of joint commitment-as-process, which goes far
85 beyond speech acts like promises. This is done (Section 4) by marshaling an authoritative but
86 underappreciated body of research on human interaction (Levinson, 2006) that describes how
87 participants enter into, continue, and exit from joint actions (Clark, 1996). The orderly social processes
88 by which they build and dissolve commitments to the various details of a joint action are amenable to
89 cross-species comparisons of the complexity of joint commitment processes. Finally, we show how
90 joint commitment-as-process and joint commitment-as-product are intertwined. The strength of the
91 sense of commitment experienced is a function of the iterative exchange of signals: the more iterations
92 participants go through to establish a commitment, the stronger is the mutual conviction about its
93 force, that is, the sense of commitment. To paraphrase Schegloff (1982), joint commitment is an
94 “interactional achievement”. Indeed, in joint actions, participants manage not one monolithic
95 commitment, but multiple, stacked commitments that are continually re-negotiated (Clark, 2006).

96 **2. Joint commitment: A brief state of the art**

97 Philosophical accounts of joint actions emphasize the fact that participants in joint actions entertain
98 “mutual” beliefs about their acting as a part of a whole. Mutual knowledge, or common ground,
99 involves each participant knowing that the other also knows x , and knowing that the other also knows
100 that one knows x , and so on (Clark & Marshall, 1982). Various authors appeal to “we-intentions”
101 (Tuomela, 2005) or reduce them to individual intentions like “I intend that we J” (Bratman, 1993)
102 (these accounts are well summarized in Tollefsen & Dale, 2012, or Michael & Pacherie, 2015).

103 For joint commitments, Gilbert (1999, p. 146) states:

104 “The joint commitment of Anne and Ben is created by Anne and Ben together. A typical way in
105 which this is done is for Anne to express to Ben her readiness to be jointly committed with him in
106 some way, and for Ben to reciprocate with a similar expression of his own, in conditions of common
107 knowledge. Roughly, something is common knowledge between two people if it is 'out in the open' as
108 far as the two of them are concerned. As both understand, the joint commitment comes into being
109 when and only when it is common knowledge that both expressions have been made.”

110 It is when reciprocal expressions of readiness to be committed become common ground that the
111 normative sense of obligation to each other and to the joint action (joint commitment-as-product)
112 arises. In Gilbert’s words (2017, p. 134):

113 “Two or more people who jointly commit themselves in some way thereby impose a normative
114 constraint on those two or more people as one. In other words they are the subject of this constraint,
115 the “one” who is constrained. This situation is the intended result of the process of joint commitment
116 described above.”

117 Gilbert (2000) points out that not all joint commitments involve agreements. However, this
118 apparently simple image of how joint commitments are established is widespread, as in Kachel et al.
119 (2018, p. 1691): “Quite often humans initiate a collaborative activity by agreeing to do so; for
120 example, one individual says “Let's X” and the other says “Okay” (or just begins collaborating).
121 Gilbert (1990) points out that this seemingly minor communicative act serves to create between
122 collaborators a mutual obligation”.

123 The sense of mutual obligation is difficult to observe directly. However, its existence can be
124 inferred when participants do not uphold their part of a commitment, as when a participant is
125 interrupted. Participants' behavior during interruptions thus constitutes a gold standard for establishing
126 evidence of joint commitments. For example, adults faced with an interruption of a joint action do not
127 simply stop interacting, but take pains to suspend it in an orderly manner, by asking permission, giving
128 explanations for the interruption, apologizing, and making efforts to reconstruct the state of the action
129 before the interruption (Chevalley & Bangerter, 2010).

130 Using experimental paradigms where participants in joint actions face defections from partners,
131 Tomasello and colleagues have demonstrated that children react similarly to adults. Very young
132 children (18-24 mo) try to reengage recalcitrant partners in a triadic social game (Warneken et al.,
133 2006), where the child interacts with an experimenter and an object (e.g., passing a ball back and
134 forth). Children understand the normative force of joint commitments from 3 years on. For example,
135 they protest when partners abruptly disengage from a collaborative game, but not when they ask
136 permission (Kachel et al., 2019), or when disengagement does not seem intentional (Kachel et al.,
137 2018). Moreover, 3-year olds are sensitive to the difference between implicit and explicit
138 commitments, being more likely to honor explicit commitments than implicit ones, whereas 5-year
139 olds are equally likely to honor both kinds (Kachel & Tomasello, 2019). Further, 3.5-year-olds (but
140 not 2.5-year-olds) keep working with partners on a joint task after having received an individual
141 reward, until the partner also receives their reward (Hamann et al., 2012).

142 Whether nonhuman animals pass the gold standard is controversial. An influential study
143 (Warneken et al., 2006) found that chimpanzees playing cooperative social games with a human
144 experimenter did not attempt to reengage experimenters who suddenly stopped playing. The authors
145 interpreted the results (p. 640) as evidence for a “uniquely human form of cooperative activity
146 involving shared intentionality that emerges in the second year of life”. This conclusion has been
147 challenged because of confounds (Leavens et al., 2019), the small sample (3 individuals) and the fact
148 that only chimpanzees were tested, in artificial interactions with human partners. Later studies with
149 bonobos (Pika & Zuberbühler, 2008) and bonobos and chimpanzees (MacLean & Hare, 2013) show
150 substantial reengagement rates after interruptions. Moreover, when interacting with conspecifics,
151 bonobos reengage social activities (e.g., social grooming) more often than solitary ones (e.g., self-
152 grooming), suggesting an additional sensitivity to “jointness”, above and beyond the potentially
153 pleasurable nature of the activity itself (Heesen et al., 2020).

154 An empirical controversy about whether great apes experience a sense of joint commitment or not
155 does not necessarily constitute a problem for philosophically-based accounts of joint commitment.
156 Indeed, it may potentially attest to the usefulness of the account for interspecies comparisons.
157 However, this account obscures a range of animal and human behaviors potentially relevant to joint
158 commitment, and is not even a realistic model of joint commitments in humans.

159 **3. Problems with philosophical accounts of joint commitment**

160 Several commentators have pointed out issues with philosophical accounts of joint action and joint
161 commitment. They are overly intellectualized, which makes them difficult to apply to cooperation not
162 involving adult humans (e.g., children, nonhuman animals or artificial agents), they tend to emphasize

163 planning at the expense of implementation, neglecting lower-level cognitive processes and knowledge
164 structures, and they remain difficult to apply to animals (Leavens et al., 2019; Tollefsen & Dale, 2012;
165 Townsend et al., 2017).

166 Philosophical accounts are difficult to apply to animals because they emphasize symbolic
167 communication at the expense of other means of expressing commitment. As such, they are difficult to
168 reconcile with, for example, the extensive literature on honest signaling developed in economics
169 (Veblen, 1899; Spence, 1973) and evolutionary biology (Zahavi, 1975). This literature suggests that
170 overt and explicit linguistic expressions of readiness to commit are not credible signals of
171 commitment, but “cheap talk” (Farrell & Rabin, 1996). Indeed, the emergence of efficient means of
172 communication like language may have created an adaptive challenge for cooperation, by increasing
173 the opportunities for Machiavellian individuals to manipulate partners and for free-riders to benefit
174 from public goods. The evolution of costly credibility-enhancing displays (Henrich, 2009) like
175 religious rituals or difficult-to-fake evidence of emotional states (Frank, 1988) or physiological
176 dispositions (Boster et al., 2003) points to the importance of nonlinguistic behavior in communicating
177 commitment. In sum, then, natural selection has likely led to the emergence of the ability for
178 commitment even before the human lineage.

179 A closer look at the account of joint commitment as a process of reciprocal expressions of
180 readiness to be committed becoming common ground suggests it may not even constitute a necessary
181 nor a sufficient condition for joint commitment in humans (Michael & Pacherie, 2015).

182 It is not a sufficient condition because many speech acts that explicitly entail commitments do not
183 necessarily function that way. A case in point concerns *ostensible invitations* (*let's do lunch sometime*,
184 Isaacs & Clark, 1990), proposals that are not meant to be taken seriously. Such invitations can even be
185 accepted by invitees (*yes, let's*), but the process by which they are established makes it clear for all
186 parties that they are only pretending to extend and accept the invitation. The ubiquity of ostensible
187 invitations robs even seriously intended invitations, proposals or promises of their potentially binding
188 character without sufficient effort by participants to demonstrate that they are indeed to be taken
189 seriously. Imagine Aaliyah suggests to Bashir *Want to go to the concert tomorrow?*, and intends this
190 invitation to be taken seriously, and imagine further that Bashir replies enthusiastically, and seriously
191 (*Great idea, I'm in!*). Without subsequent follow-up, probably neither Aaliyah or Bashir will actually
192 proceed to ordering tickets online. The difference between an ostensible and a seriously intended
193 invitation thus lies in the subsequent actions that participants undertake to make their expressed
194 commitments credible to each other (Isaacs & Clark, 1990). That, in turn, points to the importance of
195 the processes by which joint commitments are achieved (Section 4).

196 Explicit expression of readiness to commit is not a necessary condition for the emergence of a
197 sense of commitment. Building on an example from Gilbert (2006), Michael et al. (2016a) describe
198 some minimal requirements for a theory of *implicit* joint commitment. Gilbert's (2006) example
199 concerns two workers, Polly and Pam, who happen to start talking to each other during a cigarette
200 break. They repeat this practice multiple times. One day, Polly does not turn up. The next day, she
201 apologizes for her absence, explaining that she was sick. According to Gilbert, this example illustrates
202 that it has become common knowledge between Polly and Pam that they meet each day for a cigarette
203 and a chat, even though this was never explicitly agreed upon. Joint commitments can emerge
204 gradually and implicitly (Gilbert, 2000). Michael et al. (2016a) describe a minimal framework for the
205 sense of commitment, that does not require explicit statements like promises. It specifies the
206 motivational states, cognitive processes and situational factors that lead to a sense of commitment. In
207 brief, that an individual has a particular goal and perceives another individual as being in a position to
208 contribute to fulfilling it can generate expectations of commitment. Conversely, individuals who
209 perceive expectations on the part of others can feel pressured into fulfilling those expectations. The

210 authors give an example where Victor is in an elevator with the door about to close when Carla
211 arrives, visibly in a hurry. Carla may have a sense that Victor is committing to pressing the button to
212 keep the doors open, and Victor may feel committed to doing so, because he senses Carla's
213 expectation.

214 Subsequent empirical work has supported Michael et al.'s (2016a) framework. Bonalumi et al.
215 (2019) presented scenarios to participants describing existing implicit commitments (participants take
216 the perspective of a protagonists) and probing their reactions to violations of those commitments.
217 Normative opprobrium and negative emotional reactions were stronger when the protagonist on the
218 receiving end of the violation was described as having invested more effort to maintain their part of
219 the commitment, or when the joint action had been repeated more often. Using similar scenarios,
220 Bonalumi et al. (2021) showed that perceptions of whether a commitment is in effect or not depend on
221 the degree to which those commitments (one protagonist relying on the other) are perceived as
222 mutually known, irrespective of whether this has been explicitly expressed or not.

223 These studies open the door to understanding joint commitment as a graded phenomenon (Michael
224 et al., 2016a). Participants in an unfolding joint action may feel more or less committed to it. Explicit
225 agreements lead to strong perceptions of joint commitments being in place, and probably represent one
226 end of the continuum. But other cues may fuel this sense of commitment. Some of these may be
227 nonverbal signals. Children playing a cooperative game interpret particular kinds of gaze as a sign of
228 commitment (Siposova et al., 2018). Even incidental, noncommunicative behavior is interpretable:
229 Agents perceived to be highly coordinated are also perceived to be more committed to a joint action
230 than agents perceived as less coordinated (Michael, Sebanz, & Knoblich, 2016b). These examples hint
231 at the cues participants may use to infer joint commitments, but they do not exhaust the question of
232 how mutual knowledge of commitment comes about.

233 **4. Joint commitment as process: How the sense of commitment is interactionally achieved**

234 Previous research is silent on the *process* by which joint commitments are achieved. Processes are
235 usually illustrated by the trite armchair examples described in Section 2, or participants in the studies
236 by Bonalumi et al. (2019) are asked to make sense imaginary interactions (e.g., text messages to
237 arrange meetings). Some research on children or great apes (Warneken et al. 2006; Siposova et al.,
238 2018) has looked at actual communication or behavior, but focusing on controlled situations and
239 specific outcome variables. We examine the process of establishing joint commitments more
240 systematically, drawing on an authoritative body of research on human interaction, prominently
241 featuring conversation analysis (Sacks, Schegloff, & Jefferson, 1974; Sidnell & Stivers, 2012) and the
242 psychology of language use (Clark, 1996), that has examined social interaction and cooperation
243 (Kendrick & Drew, 2016) processes in detail. As we will see, this literature substantially complexifies
244 the question of process. Joint commitments are not constituted of a single, monolithic agreement, but
245 rather a multitude of incremental agreements that are built up, maintained and dissolved in the course
246 of interaction. Initial, generic commitments to interact are built on existing ones even prior to
247 interaction, and even getting participants' bodies into a spatial configuration where explicit agreements
248 are feasible and appropriate requires coordination (Youssof, Grimshaw, & Bird, 1976).

249 We examine three aspects of joint commitment processes that are more complex than previously
250 assumed, and their implications for cross-species research on joint commitment: prior interactions,
251 generic joint commitment processes and the incremental construction of specific commitments.

252 **4.1. Joint commitments prior to interaction**

253 **4.1.1. In humans**

254 Many consequential social interactions occur within existing social relations. Humans live in
255 environments (e.g., work, school, the home) where they repeatedly encounter the same people (Hill &
256 Dunbar, 2003). This often creates situations of *incipient talk* (Schegloff & Sacks, 1973) where lapses
257 in conversation do not constitute the end of the interaction. As such, most encounters are repeats of
258 previous encounters (as in the Polly-and-Pam example, Gilbert, 2006). At the very least, they feature
259 *precedents*, a powerful resource for coordinating joint action: Simply doing something once creates
260 expectations about how it could be done again (Brennan & Clark, 1996). Repeated precedents give
261 rise to conventions (Lewis, 1969), which spread among communities and self-perpetuate (Garrod &
262 Doherty, 1994). Massively recurring joint actions are built into institutions that populate everyday
263 social life, in the form of routines, roles, frames, scripts or plans which create accountability,
264 predictability and shared understanding (Okhuysen & Bechky, 2010).

265 As a result, many joint actions do not require explicit expressions of agreement (Gilbert, 2014).
266 Getting behind the wheel of a car implies a commitment to following the rules of the road; walking
267 onto the tennis court as a player implies a commitment to play tennis according to the rules; and
268 standing in line at Starbucks implies a commitment to order coffee (Clark, 2005). Institutionalized
269 commitments efficiently enable complex joint actions. A simple drive through town involves intricate
270 predictions about how other drivers or pedestrians will behave, and the vast majority of the time, these
271 predictions are correct.

272 A sense of commitment can thus emerge from the cognitive and material residues of previous
273 interactions. These can be precedents, where the historicity of the previous interaction is still fresh for
274 participants, or in conventions, rules, routines, and scripts, where it may be lost in the mists of the past.
275 These constitute common ground (Clark & Marshall, 1982), knowledge that participants mutually
276 assume they share. Repetition of joint actions thus affects the sense of commitment, probably by
277 providing cues about participants' expectations (Bonalumi et al., 2021). But repetition also affects the
278 processes by which joint commitments are established. It is important to note that the mutual
279 knowledge from past interactions is not only shared in participants' brains, but encoded in the material
280 surroundings of institutionalized life (Hutchins, 1995), like turn signal lights on cars, lines on a tennis
281 court, or a barista's uniform at Starbucks. These traces embody normative expectations that constrain
282 participants' actions, making those actions predictable and the participants accountable (Clark, 2005;
283 Enfield & Kockelman, 2017).

284 **4.1.2. In animals**

285 Interactions between animals also occur within existing social relations, which opens up the
286 possibility of rudimentary forms of commitment being based on precedents encapsulated in those
287 interactions. Social animals keep track of past interactions they have had with partners (e.g., affiliative,
288 aggressive) or they have observed as a third party. They also represent their social relationships with
289 others and of others (hierarchy, social bond, and kinship) (Mitani, 2009; Silk et al., 2006). This
290 knowledge can create precedents and expectations about how to behave with a specific partner, and
291 how to communicate (Von Rohr et al., 2011). Thanks to pragmatic inference, nonspecific signals can
292 convey highly specific information (Seyfarth & Cheney 2016). Based on a mental representation of
293 the type of signal, the signaller's identity, recent events, the signaller's dominance rank and kinship
294 affiliation, and the signaller's and receiver's relationships with others, receivers assess the meaning of
295 signals (Cheney & Seyfarth, 2007). For instance, in baboons, listeners respond with surprise to calls
296 violating the dominance hierarchy, suggesting they have expectations about "rules" of call production
297 and knowledge of the relative ranks of individuals (Cheney et al., 1995). Similarly, great apes adjust
298 their communication to their partner's identity (Genty et al. 2015; Heesen et al., 2020, 2021) and to
299 their shared knowledge (Bohn et al. 2016). The development of their communicative repertoires also
300 depends on the extent of their interactional history and social exposure (Fröhlich et al. 2016, Pika and

301 Fröhlich 2020). Animals can also behave appropriately based on expectations. Chimpanzees possess
302 expectations about the behaviour of others towards themselves as well as “personal norms” (Von Rohr
303 et al., 2011). For instance, they are more likely to cooperate with individuals known to be more
304 tolerant (Melis et al., 2006) and other non-human primates even penalize violations of those rules
305 (Kappeler et al. 2019).

306 Many ape and monkey species build coalitions to hunt prey or attack ingroup conspecifics or
307 isolated outgroup individuals. Coalitions decrease risk of injury for their members, but present a
308 “volunteer’s dilemma” (Willems et al., 2015): Individuals jumping into the fray may not be followed
309 by partners, who have a selfish incentive to hold back, profiting from the outcome without risking
310 injury. Coalitions thus would benefit from coordinating about joint commitment. But do they?
311 Experiments with pairs of chimpanzees in a stag-hunt-style foraging game suggests that individuals do
312 not coordinate before forsaking a lower-value food source for a higher-value one, with one individual
313 taking the initiative and presumably hoping the other will join them (Duguid et al., 2014). On the other
314 hand, in border patrolling, pairs of male chimpanzees who groom together and form within-
315 community coalitions are more likely to patrol together (Watts & Mitani, 2001), again suggesting a
316 role of preexisting relations in coordinating commitments.

317 4.2. Generic joint commitments

318 4.2.1. In humans

319 Joint actions entail solving *generic* coordination problems: Reaching agreements on participants,
320 their roles, the content of the actions, and their timing and location (Clark, 2006). In institutionalized
321 interactions like ordering coffee at Starbucks, many elements are predetermined and require little to no
322 explicit agreements (indeed, it would be odd for participants to discuss them). Customers play their
323 role by standing in line, and ordering and paying when it is their turn. Baristas play their role behind
324 the counter, preparing coffee and handing it to customers. But what about impromptu joint actions?
325 When no institutional scripts or routines are available, participants need to solve these problems *ad*
326 *hoc*. When participants are physically co-present, additional coordination problems must be solved:
327 reaching an initial commitment as to the possibility of joint action, performing the joint action and
328 maintaining commitments to it in the face of competing joint actions, and closing down the
329 commitments once the action is complete. There are procedures for solving these problems, which
330 Goffman (1959, 1967) described as the *interaction order*, that is, the rules and rituals governing social
331 interactions in everyday life. As a result, joint actions typically unfold in three macro-level phases
332 (Clark, 1996): The opening, the main body and the closing (Fig. 1). In the following, we describe the
333 generic coordination problems that must be solved in each phase and the behavioral and
334 communicative outputs produced to those ends. These problems and outputs are described in a
335 language-agnostic manner to maintain the potential applicability of the framework in Fig. 1 to humans
336 and nonlinguistic animals alike.

337 Generic coordination problems in the opening phase involve *selecting partners* and *establishing*
338 *mutual attention* before making intentions clear. Participants need to understand who is involved
339 (*establish participation framework*), what type of actions are to be performed, where and when, and
340 what the respective roles will be (*determine nature and content of activity and roles*) (Clark, 2006;
341 Goffman, 1981b; Kendon, 1990; Mondada, 2009). In the main body, transitions from one part of the
342 action to another can be coordinated via linguistic signals like discourse markers (e.g., *and, so, but*,
343 Schiffrin, 1987) or back-channel utterances (*mhm, uh-huh*, Bangerter & Clark, 2003). In committing
344 themselves to a joint action, participants renounce opportunities to engage in other activities and their
345 commitments need to be continuously re-affirmed. If joint actions are interrupted, participants
346 coordinate on suspending them by *justifying the necessity to suspend*, to avoid perceptions of breaking

347 the commitment (thus threatening their partners' face and their own reputation, Brown & Levinson,
348 1987; Goffman, 1967), before *breaking mutual attention* and attending to the source of the
349 interruption. Later, they coordinate on *reinstating the joint action*, by *checking their partners'*
350 *availability* and *re-establishing mutual attention*, and resuming the previous action. Finally, in the
351 closing phase participants coordinate on *reaching agreement to end the joint action* (Schegloff &
352 Sacks, 1973). They then *ensure the continuity of their relationship* before *taking leave* of one another
353 and *breaking mutual attention*.

354 To solve these problems, in the opening phase, various communicative and behavioral outputs are
355 produced. The establishment of participation frameworks is evidenced by *approach* towards potential
356 partners (Kendon, 1990), *mutual orientation of bodies*, *gaze* to select participants, and *mutual gaze*
357 (Goodwin 2007, Rossano, 2013a) to display availability (Kendon, 1990; Rossano, 2013a) and
358 establish mutual attention (Goffman, 1981; Kendon, 2004). The opening phase also features *greeting*
359 *signals* (De Stefani & Mondada, 2018; Youssouf, Grimshaw, & Bird, 1976, Pillet-Shore, 2018a,
360 2018b), and signals to determine the content (*activity-specific initiation signals*), location and timing
361 of the joint action (Clark, 1996) and the respective roles of participants. Partners *greet* each other and
362 display intentions to touch, hug or kiss each other before they even start talking (Kendon, 1990;
363 Mondada, 2009; Pillet-Shore, 2018a).

364 In the main body, communicative and behavioral outputs include *mutual gaze*, which represents
365 feedback and a way to monitor each other, or to elicit evidence of continued engagement in the
366 activity (Bavelas et al., 2002). If an interruption occurs, participants may communicate to suspend the
367 interaction ("*suspension*" signals). The person responsible might also apologize for keeping their
368 partners waiting (*Sorry, I have to deal with this*). If commitments are broken without appropriate
369 acknowledgement, *manifestations of frustration, protest or sanction* can be observed. Participants
370 reinstate the action by checking availability of their partner via *mutual gaze* (Chevalley & Bangerter,
371 2010) before reengaging them, potentially via communicative signals (*reengagement signals*). The
372 activity is then reinstated by continuing the action suspended before the interruption (*continuation of*
373 *behaviour*) e.g., reconstructing the topic of conversation (*Where were we?*).

374

375

--- FIGURE 1 HERE ---

376 **Figure 1.** Joint commitment as a process. Solving generic coordination problems, behavioral and
377 communicative outputs, and corresponding phases.

378

379 In the closing phase, communicative and behavioral outputs include displays of the intention to end
380 the interaction by *stopping related behaviours*, disrupting mutual attention and *turning bodies and*
381 *heads away*, thus suggesting the upcoming end of the interaction, which remains negotiable until
382 officially agreed upon (Broth and Mondada, 2013). Readiness to end is expressed through sequences
383 like "*okay – okay*". Once agreement has been reached, participants engage in *leave-taking*. This
384 includes reminiscing about the encounter, expressing pleasure at having shared company, projecting
385 continuity of the relationship to future encounters (e.g., *see you tomorrow*) and well-wishing (*good-*
386 *bye*) before walking away (Albert & Kessler, 1976; Broth & Mondada, 2013; Clark & French, 1981;
387 Schegloff & Sacks, 1973).

388 The processes described in Fig. 1 reflect participants' relationship. This is evidenced in the use of
389 politeness to manage face (Brown & Levinson, 1987). Threats to face increase with social distance and

390 power difference between partners, and are compensated with politeness. People are more polite when
391 interacting with higher status and unfamiliar individuals, compared with lower status and familiar
392 individuals. For instance, in closings, strangers produce more external justifications, more well-
393 wishing statements, and more statements of positive affect than do friends (Albert and Kessler, 1978),
394 and friends produce less head-nodding and look away more than do strangers (O’Leary and Gallois,
395 1985).

396 **4.2.1. In animals**

397 The phenomena in Fig. 1 represent a framework to compare joint commitment processes across
398 species. For example, it can be extended to describe similar phenomena like shared intentionality in
399 different species in the context of play (Heesen et al., 2017) or grooming (Genty et al., 2020). Some
400 studies have documented establishment of participation frameworks in bonobos and chimpanzees
401 (Fröhlich et al., 2016; Rossano, 2013b). Heesen et al. (2020) conducted targeted interruptions of
402 bonobos engaged in social activities. Bonobos often (>80% of the time) resumed the activities after
403 interruptions. Social activities were resumed more frequently than solitary activities, suggesting that
404 bonobos feel some sense of commitment. Further, Heesen et al. (2021) coded the presence and
405 duration of potential opening and closing phases in play and grooming interactions in chimpanzees
406 and bonobos. These phases were defined as exchanges of signals or behavior before the main action
407 starts (e.g., the first grooming move). Opening phases thus defined occurred in 90% of bonobo
408 interactions and 69% of chimpanzee interactions. Openings in both species, lasted around 12 seconds
409 on average. Closing phases thus defined occurred in 92% of bonobo interactions and 86% of
410 chimpanzee interactions, lasting around 14-17 seconds on average. Moreover, bonobos with closer
411 relationships were less likely to produce openings and closings than those with more distant
412 relationships.

413 In this framework (Fig. 1), the question remains to what extent different species use specific signals
414 to solve these coordination problems, e.g., specific signals to open joint actions or close them. Of
415 course, language allows expressing subtle information about the particular circumstances of an
416 opening, closing or other phase. Many animal species have greeting signals (Fedurek et al., 2019), but
417 not signals more specific to each phase, and leave-taking signals may be less frequent (Rodrigues et
418 al., 2021). Mutual gaze is widespread as a potential signal of mutual orientation and commitment in
419 humans (Bavelas et al., 2002; Rossano, 2013a, Siposova et al., 2018) and many primate species (Bard
420 et al., 2005). While it is often difficult to determine its precise function, some results are suggestive of
421 joint commitment. Miss and Burkart (2018) found that marmosets engaged in a joint Simon task
422 engage in mutual gaze significantly more often before performing a joint version of the task than a
423 control version.

424 **4.3. Specific joint commitments**

425 **4.3.1. In humans**

426 It should be clear from the generic joint action processes described previously that promising and
427 accepting is not the beginning of the joint commitment process. Although participants may try to
428 establish explicit agreements early on, the coordination problems that must be solved in the opening
429 phase before they can do so may take any time from seconds (one person approaching another on the
430 street; De Stefani & Mondada, 2018) to hours (two caravans sighting each other in the desert;
431 Youssouf, Grimshaw, & Bird, 1976). Before explicitly soliciting commitments, participants often
432 engage in pre-sequences (Schegloff, 2007) to indirectly ascertain if an invitation or offer is likely to be
433 accepted. Moreover, even when an explicit commitment has been established (Aaliyah: *Want to go to*

434 *the concert tomorrow?* Bashir: *Great idea, I'm in!*), much uncertainty remains as to how it is to be
435 honored, and participants need to create further, more specific joint commitments. In impromptu joint
436 actions, these are created piecemeal (Clark, 2006). Thus, the next coordination problem Aaliyah and
437 Bashir need to solve is buying tickets. Aaliyah might suggest they each buy tickets separately, or she
438 might ask Bashir to get tickets for both of them. And so on. Going to a concert together involves the
439 creation of multiple joint commitments following on the initial agreement.

440 Clark (2006) proposed that joint commitments have two key properties: Stacking and persistence.
441 First, commitments *stack up* hierarchically in the course of an interaction. That is, initial commitments
442 serve as the foundation for subsequent, more specific commitments. Second, these commitments
443 *persist*. If Aaliyah suggests that Bashir buys tickets for both of them, and he demurs, he still remains
444 committed to going to the concert with her. Moreover, specific commitments can be entailed by lower-
445 level (e.g., perceptual or motor) processes once initial commitments are established (Tollefsen & Dale,
446 2012). Once we agree to play tennis, and I serve you the ball, you are committed to hit it back, and
447 you will do so without so much as a fleeting thought, and so on, until one of us scores a point.

448 According to Clark (2006), stacking and persistence explain the risky nature of joint commitments.
449 Indeed, the more participants advance in a joint action, the more commitments they accumulate. These
450 make it increasingly difficult to back out of the joint action, and expose participants to risks of
451 exploitation and overcommitment. In the famous Milgram experiment, each subsequent dose of
452 electric shocks delivered to the student by the participant constitutes an additional barrier to
453 the participant's ability to quit (indeed, participants who did end up quitting tended to start resisting
454 early on; Modigliani & Rochat, 1995). The Milgram experiment is a dramatic example of how the
455 accumulation of commitments can subtly and progressively change the nature of the original
456 commitment. This principle is of course the foundation of many persuasion techniques like the foot-in-
457 the-door technique, used by salespersons and con artists alike (Joule et al., 2007).

458 **4.3.2. In animals**

459 Joint action in humans is much more complex and thus requires much more specific commitments
460 than in nonhuman animals. However, many animal species may engage incrementally in specific
461 commitments in joint actions like play (Palagi, 2008), where in the course of a bout, transitions
462 between types of play or role switches (in chase play, chaser becomes chasee) are signaled by specific
463 signals (Heesen et al., 2017). And in coalitions formed for intergroup conflict, chimpanzees who
464 encounter pant-hoot calls of extragroup males engage in a loud chorus of vocalizations (Wilson et al.,
465 2001), which may serve as an activity-specific commitment signal.

466 **5. Conclusion**

467 Joint commitment is a crucial enabling condition of joint action (Gilbert, 2017). There is much to
468 gain from enriching its current conceptualization, not least the potential for a better understanding of
469 how highly mentalized joint commitments in adult humans may have emerged from earlier forms of
470 proto-commitments in other species. We explored several potential enrichments, moving from explicit
471 to implicit commitments and to the insight that the sense of mutual obligation at the heart of joint
472 commitment is graded and not binary (Michael et al., 2016a). We also suggested that the processes by
473 which joint commitments are established are as important as its product. Indeed, product and process
474 interact: The flavor and strength of a particular sense of commitment is affected by the coordination
475 processes by which it was brought about.

476 Joint commitment processes are affected by prior joint actions, which create precedents and
477 conventions that can be embodied in material arrangements of institutions. Joint commitment
478 processes also arise as solutions to generic coordination problems related to opening up, maintaining

479 and closing down joint actions. Finally, in the course of joint actions, additional commitments are
480 made piecemeal. These stack up over time and persist, making it difficult for participants to
481 unilaterally disengage from joint actions (Clark, 2006). The standard account of the joint commitment
482 process as participants' reciprocal expressions of readiness to perform a joint action (aka agreements)
483 is thus revealed to be a very special case.

484 Philosophy has made an important contribution to explicating the meanings of "joint" or
485 "collective" forms of intentionality and action. But the enriched understanding of joint commitment
486 processes in the real world sketched out here has been enabled by several decades of empirical
487 research on human social interaction (Levinson, 2006). Productive inquiry into the evolution of joint
488 action phenomena guided by concepts and findings from interactional research (Fröhlich et al., 2016;
489 Genty et al., 2020) is already under way. Joint commitment is next in line.

490

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