Figure S1: Related to Table 1

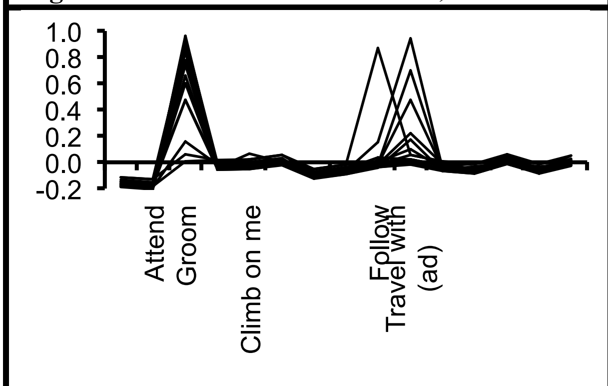
Individual use of gesture types: graphical analysis

The mean percentage deviation from the normal distribution of ASOs in gestural communication is plotted per signaler for the 15 gesture types suitable for parametric analysis; followed by the 21 gestures analyzed with non-parametric analysis (see Table S3: evidence). Number of individual signalers and total number of cases of the gesture are provided. *ASOs with potentially similar meaning are plotted adjacent to each other.* Each line represents a distribution of usage across the ASOs; the weight of the line correlates directly to the number of signalers that employed this distribution of meaning. *For clarity only ASOs for which the gesture was employed are labelled.*

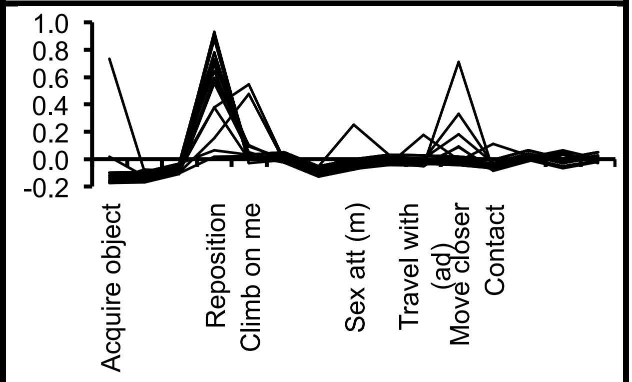
*Note that, in the gestures analyzed with parametric analysis individual contributed several cases of the gesture: thus any single errors (either in attribution by the coder, or understanding by the recipient) represent only a portion of the individual signaler's usage. For gestures analyzed through nonparametric analysis, an individual may contribute only a single case of the gesture so, even where this was an error it then represents 100% of their usage. Thus, errors and variation are potentially exaggerated with respect to distributions shown in Figure S1.

15 gestures analyzed through parametric analysis (Table S3)

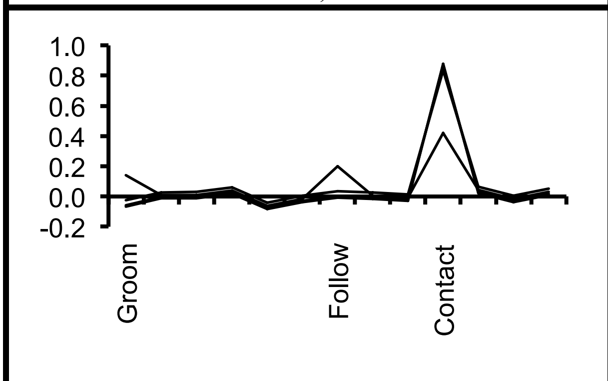
Big Loud Scratch: individuals n=18, cases n=177



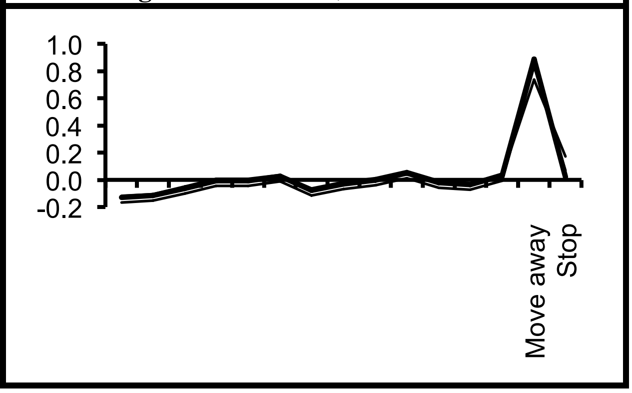
Directed push: individuals n=16, cases n=157

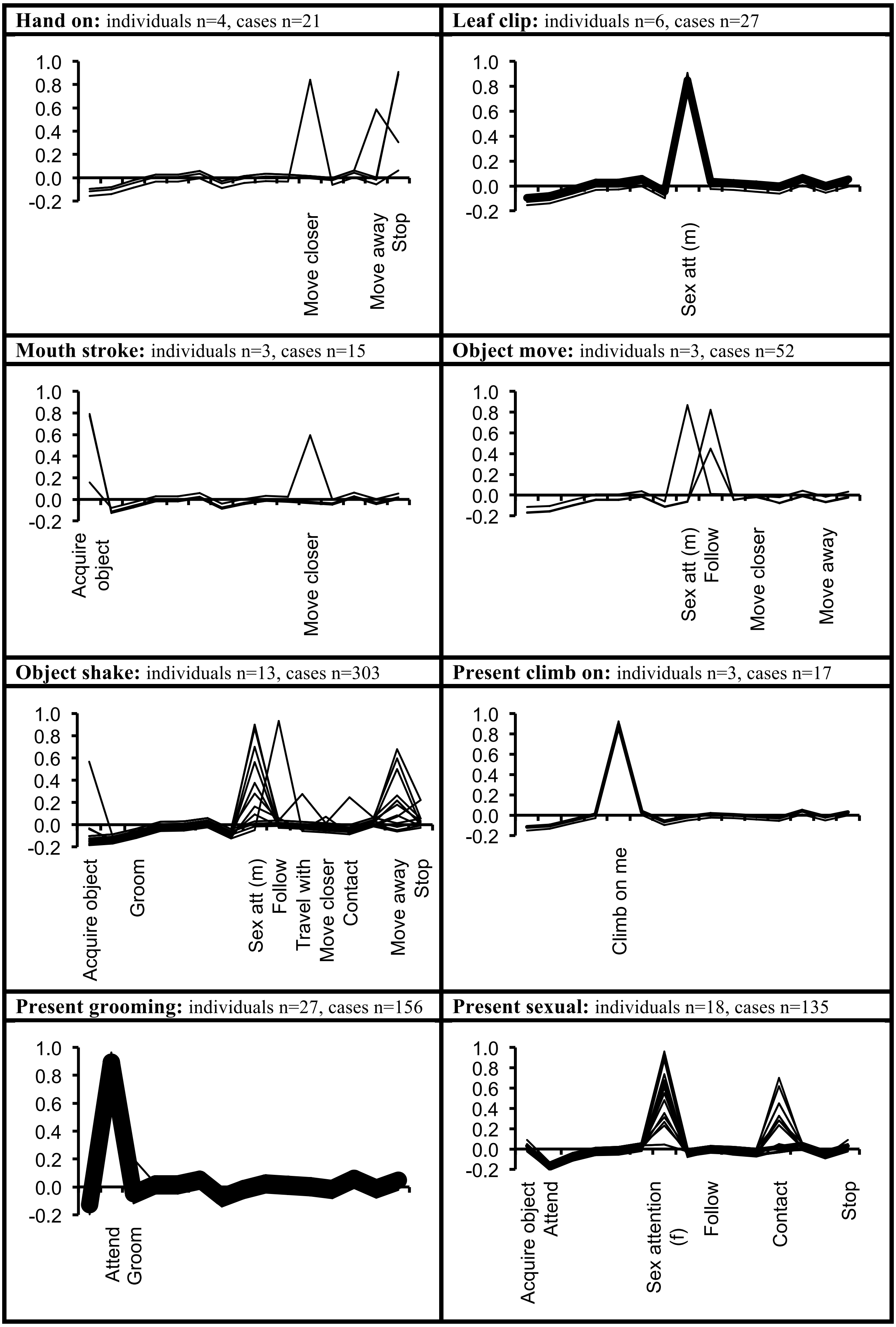


Embrace: individuals n=4, cases n=118

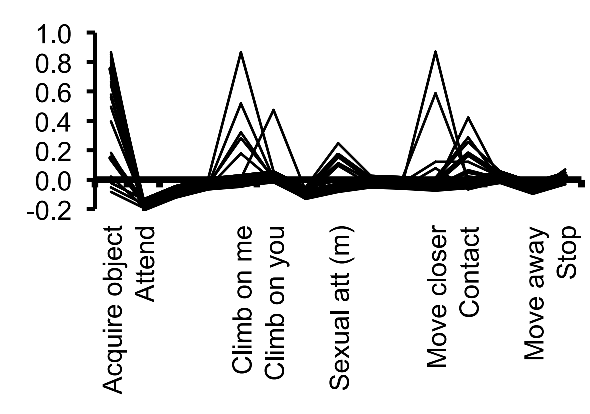


Hand fling: individuals n=5, cases n=39

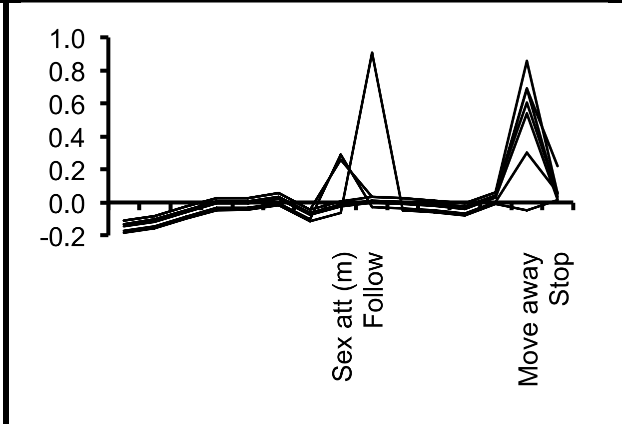



Hand on: individuals n=4, cases n=21
Leaf clip: individuals n=6, cases n=27
Mouth stroke: individuals n=3, cases n=15
Object move: individuals n=3, cases n=52
Object shake: individuals n=13, cases n=303
Present climb on: individuals n=3, cases n=17
Present grooming: individuals n=27, cases n=156
Present sexual: individuals n=18, cases n=135
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
Move closer
Move away
Stop
Sex att (m)
Acquire object
Follow
Groom
Travel with
Contact
Climb on me
Attend
Sex attention (f)

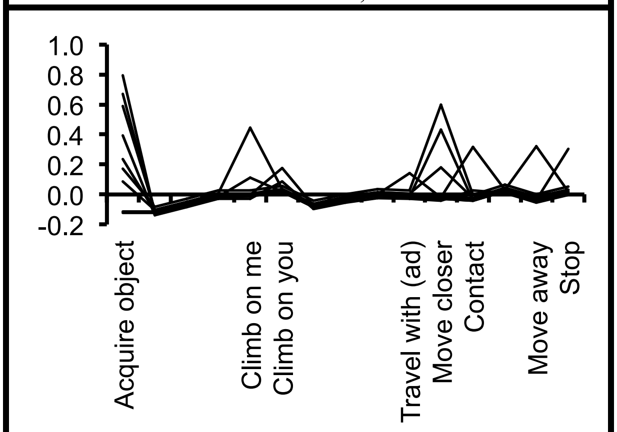
Reach: individuals n=25, cases n=228



Slap object: individuals n=7, cases n=48

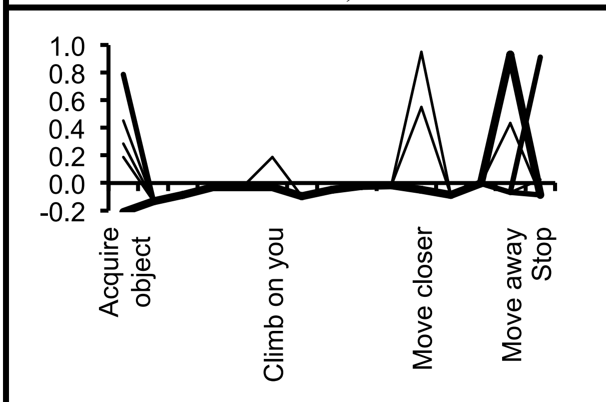


Touch other: individuals n=9, cases n=42

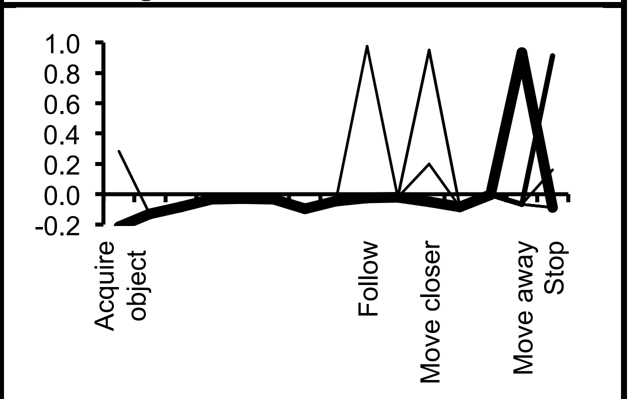


21 gesture analyzed through non-parametric analysis (Table S3)*

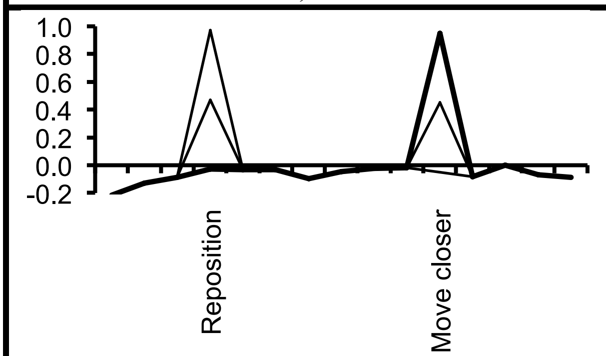
Arm raise: individuals n=12, cases n=27



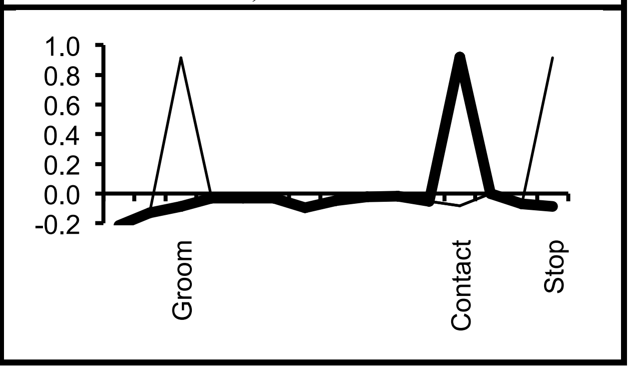
Arm swing: individuals n=10, cases n=39



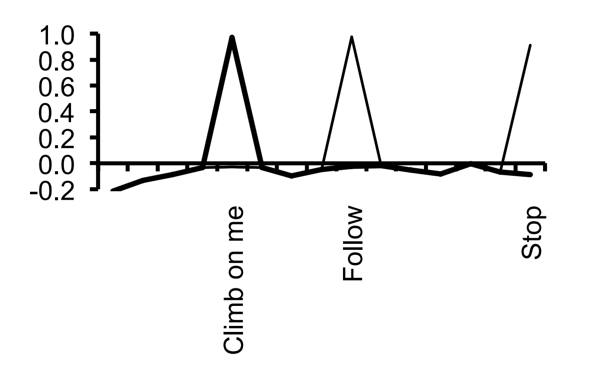
Beckon: individuals n=4, cases n=6



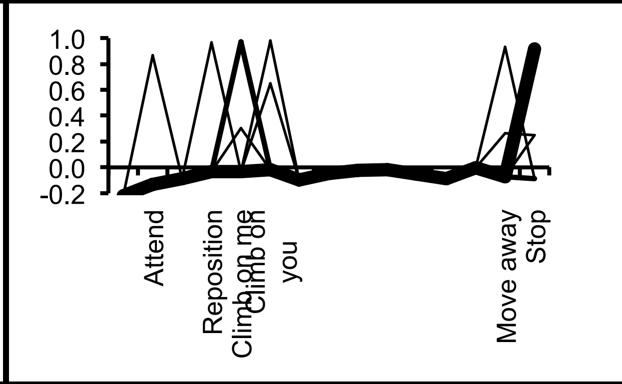
Bite: individuals n=6, cases n=7



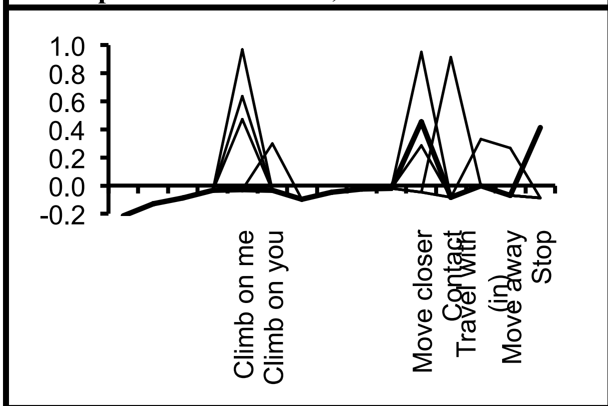
Foot present: individuals n=4, cases n=8



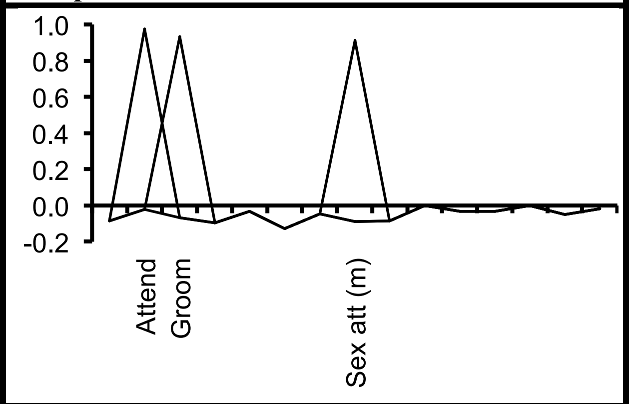
Grab: individuals n=13, cases n=19



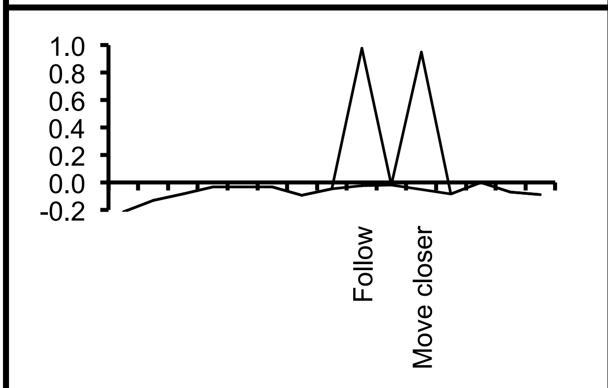
Grab-pull: individuals n=8, cases n=16



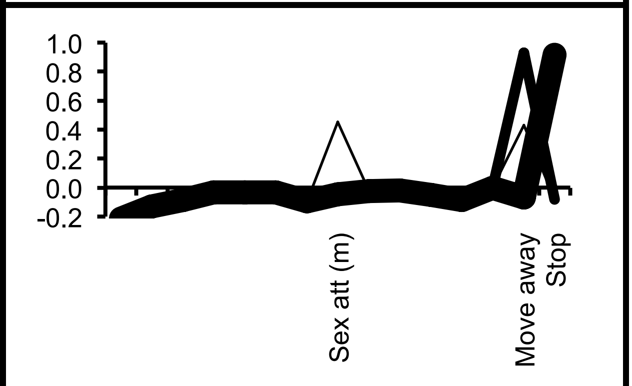
Jump: individuals n=3, cases n=18



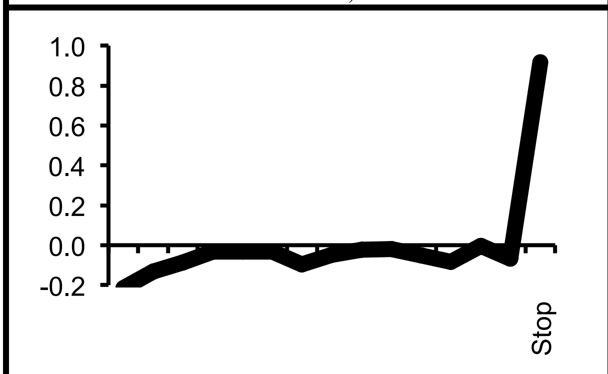
Slap object with object: individuals n=2, cases n=15



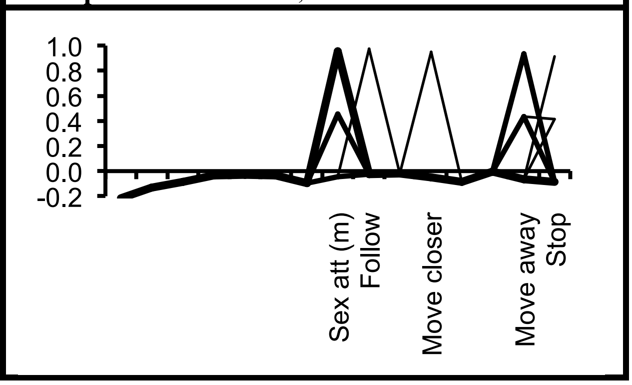
Slap other: individuals n=14, cases n=17



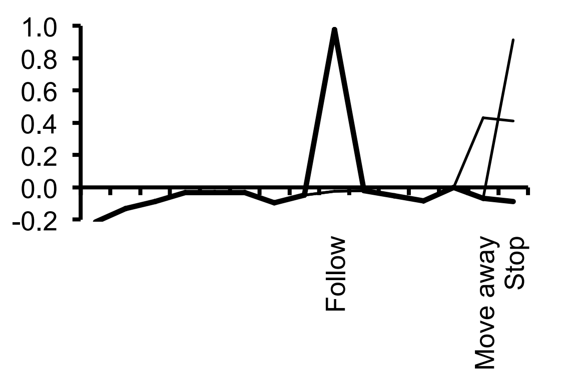
Somersault: individuals n=6, cases n=15



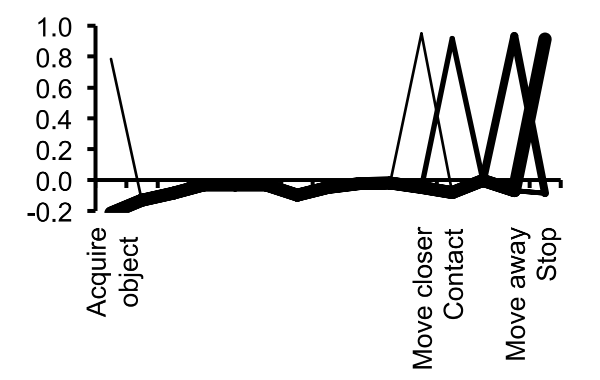
Stomp: individuals n=12, cases n=30



Stomp 2-feet: individuals n=5, cases n=10



Tap other: individuals n=12, cases n=15



Throw object: individuals n=1, cases n=5*

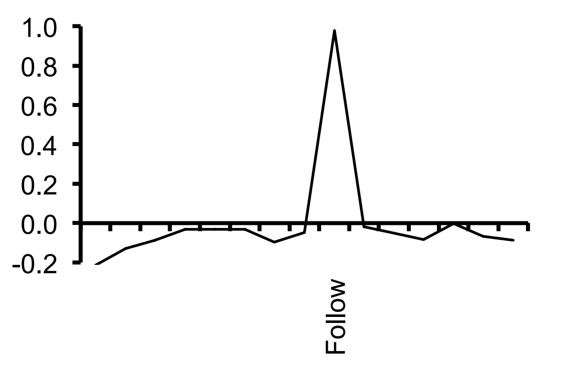


Table S1: Related to Table 2

Apparently Satisfactory Outcomes in chimpanzee gestural communication. Definitions of ASOs are provided along with the percentage frequencies with which single gestures or bouts of gesturing were employed towards a particular ASO; raw frequencies of the number of gesture instances are given in brackets (n).

*Note that the 'Unknown' category does not accurately reflect the rate of failed communication attempts: since the definition of a gesture requires evidence of intentional usage, many genuinely communicative instances were liable to be missed, and these may disproportionately include cases where the target audience does not react.

ASO	Definition	Gestures % (n)	Bouts % (n)
Acquire object	recipient gives signaler object (e.g. food, leaf sponge, etc.)	6.3% (283)	4.8% (164)
Attend to specific location	recipient adjusts their behavior to focus attention on the location indicated in the signaler's gestural communication, usually in grooming	4.0% (183)	5.0% (172)
Climb on me	recipient climbs on signaler's body	1.8% (83)	2.1% (72)
Climb on you	recipient permits signaler to climb on them	0.3% (15)	0.4% (13)
Contact	physical contact of an apparently affiliative nature, such as hugging, touching etc. between the signaler and recipient	2.9% (132)	3.5% (119)
Follow me	mature recipient follows mature signaler, usually in consortship	8.2% (373)	4.2% (145)
Initiate grooming	grooming between the signaler and recipient	3.8% (174)	4.2% (143)
Move away	recipient moves away from signaler	3.8% (170)	3.8% (129)
Move closer	recipient moves closer to signaler	2.4% (107)	2.2% (75)
Play start	recipient starts to play with the signaler	42.7% (1933)	43.4% (1485)
Play change: increase intensity	recipient changes the type of play from chasing play to contact (e.g. wrestling) play	0.7% (33)	0.8% (26)
Play change: decrease intensity	recipient changes the type of play from contact to chasing play	0.1% (3)	0.1% (3)
Play resume	recipient resumes playing after a pause in the activity	5.7% (257)	6.3% (214)
Reposition body	the recipient moves (and holds) their body into the indicated position	2.2% (100)	2.7% (93)
Sexual attention to female	(male) recipient responds sexually to signaler attention (e.g. inspection, copulation etc.)	2.4% (107)	2.0% (69)
Sexual attention to male	(female) recipient responds sexually to signaler (e.g. presentation, copulation, etc.)	1.7% (110)	3.1% (107)
Stop that	the recipient either ceases behavior previously directed towards the signaler or changes their behavior to direct it towards another individual	3.2% (145)	3.7% (127)
Travel with me (adult)	recipient travels together with adult signaler	0.8% (36)	0.5% (18)
Travel with me (infant)	recipient travels together with infant signaler	0.1% (3)	0.1% (1)
Unknown*	intentional gesture fails to elicit any response, so unable to attribute the intended purpose	6.3% (284)	7.1% (244)

Table S2: Related to Table 1

Individual use of gesture types: statistical analysis. A significant result indicates that the gesture has a distinct meaning, which does not vary with signaler identity. A significant t-test or G-test result indicates a population-general effect: that is, that there is *no* significant effect of signaler identity on the pattern of use of an individual gesture type (for its primary; primary and secondary; or primary, secondary and tertiary ASOs combined). ASOs were derived from the analysis of data from all individuals, shown in table S3; tests were run on the subset of individuals who contributed at least 3 cases of gesture use, as in the parametric analyses in table S3.

*All cases of gesture use tested were towards the primary ASO

Gesture	**ASOs: primary (secondary) [tertiary]**	**ASOs tested**	**Evidence**
Big loud scratch	Initiate grooming	1	T=2.88, df=17, p=0.010
Directed push	Reposition body (Move closer)	1,2	T=3.26, df=15, p=0.005
Embrace	Contact (Travel with me adult) [Follow me]	1,2,3	T=7.00, df=3, p=0.006
Hand fling	Move away (Stop that)	1	T=11.00, df=4, p<0.001
Hand on	Stop that (Acquire object) [Contact]	1,2,3	T=0.46, df=3, p=0.680
Leaf clipping	Sexual attention to male*	1	G=37.4, df=1, p<0.001
Mouth stroke	Acquire object (Move closer)	1,2	G=20.8, df=1, p=0.003
Object move	Sexual attention to male (Move away) [Follow]	1,2,3	T=13.46, df=3, p=0.005
Object shake	Move away (Sexual attention to male) [Acquire object]	1,2,3	T=3.21, df=12, p=0.008
Present climb on	Climb on me*	1	G=23.6, df=1, p<0.001
Present grooming	Attend to specific location	1	T=34.96, df=26, p<0.0001
Present sexual	Sexual attention to female (Contact)	1,2	T=14.20, df=17, p<0.0001
Reach	Acquire object (Contact)	1,2	T=3.134, df=24, p=0.005
Slap object	Move away (Stop that) [Sexual attention to male]	1,2,3	T=2.34, df=6, p=0.058
Touch other	Acquire object (Contact) [Stop that]	1,2,3	T=1.02, df=8, p=0.338

Table S3: Related to Tables 1 and 2

Gesture meanings. Most commonly recorded ASOs, for each gesture type. Percentages are calculated from cases of non-play gestural communication and do not include cases assigned an ASO of 'unknown'. Only the commonest two ASOs recorded are shown; data are from all individuals, with each individual's raw score converted to a proportion.

We carried out individual ANOVAs or Chi-square tests as appropriate for each of the 36 gestures suitable for analysis, comparing the ASO distribution for each gesture against the null distribution of the ASOs in the data set as a whole (see SI Procedure). In addition we attempt to identify gesture types specifically employed in play communication; we analyze all usage (including play) for the 18 gestures where insufficient evidence of meaning was available from non-play contexts.

Statistical evidence is provided for any interaction between gesture type and distribution of ASOs, tested using either an ANOVA, or, where insufficient cases for parametric analysis, Chi-square with individual data pooled. A significant finding indicates that the distribution of ASOs for the specific gesture types varies significantly from the null distribution of ASOs. N is the number of individuals contributing data to the test, which is the number of subjects tested when the statistical test is an ANOVA in the adjacent 'evidence' column; note that for parametric tests only individuals contributing at least 3 cases of gesture use were included (see SI Procedure_d). The total number of cases of gestures used (n) is also provided, and this is the number of subjects tested when the adjacent statistical test is a Chi-square. Individual identity was coded and treated as a random variable in all ANOVAs.

* It was not possible to control for individual identity in Chi-square tests; thus, p values of chi-square tests should be interpreted with caution. See SI Procedure_d for discussion of the interpretation of pooled data.

** Throw object was recorded 100% of the time towards a single outcome ('follow me'), but with only 5 cases the interaction only approached significance (p=0.08).

*** Note that in the case of gestures analyzed with play data, because of the prevalence of play data within the total (null) data set, a failure to show deviation from the null is here much more likely. While a significant result will indicate a specific pattern of use for that gesture type, a non-significant result does not necessarily indicate that there is no specific pattern of use: rather it gives no information in either direction. While 17 of the 18 gestures had a tight meaning of 'play start', the extremely high frequency with which play was recorded as an outcome in the dataset meant that for 8 gestures the distribution of ASO did not vary from the overall average distribution of ASOs. While this does not represent a significant proportion of the repertoire (Binomial: n=18, p=0.815), the non-significance is likely due to the overwhelming predominance of play data in the set, and should only be interpreted as providing no specific evidence, rather than evidence against meaningful use of gestures used in play.

Gesture meanings: non-play			
gesture type	ASO (%) all individuals	N (n)	evidence*
Arm raise	Acquire object 38% (Move away 29%)	12 (27)	χ^2=65.71, df=14 p<0.0001
Arm swing	Move away 40% (Move closer/Stop that 23%)	10 (39)	χ^2=62.64, df=14 p<0.0001
Beckon	Move closer 63% (Reposition body 38%)	4 (6)	χ^2=52.30, df=14 p<0.0001
Big loud scratch	Initiate grooming 82% (Travel with me - adult 9%)	18 (177)	f=45.33, df=14, 238 p<0.001
Bite	Contact 67% (Stop that/Initiate grooming 17%)	6 (7)	χ^2=37.76, df=14 p=0.0006
Directed push	Reposition body 57% (Move closer 15%)	16 (157)	f=29.13, df=14, 210 p<0.001
Embrace	Contact 89% (Travel with me – adult 7%)	4 (18)	f=33.83, df=14,42 p<0.001
Foot present	Climb on me 50% (Follow me/Stop that: 25%)	4 (8)	χ^2=104.17, df=14 p<0.0001
Grab	Stop that 44% (Climb on me 18%)	13 (19)	χ^2=123.57, df=14 p<0.0001
Grab-pull	Move closer 35% (Climb on me 27%)	8 (16)	χ^2=117.36, df=14 p<0.0001
Hand fling	Move away 73% (Stop that 27%)	5 (39)	f=427.5, df=14,56 p<0.001
Hand on	Stop that 50% (Acquire object 25%)	4 (21)	f=3.28, df=14,42 p=0.001
Jump	Follow me/Stop that/Move away 33%	3 (18)	χ^2=48.47, df=14 p<0.0001
Leaf clipping	Sexual attention to male 89% (Sexual attention to female 11%)	6 (27)	f=1925.79, df=14,70 p<0.001
Mouth stroke	Acquire object 93% (Move closer 7%)	3 (15)	f=4.18, df=14,28 p=0.001
Object move	Sexual attention to male 45% (Move away 26%)	3 (52)	f=2.16, df=14,28 p=0.041
Object shake	Move away 37% (Sexual attention to male 35%)	13 (303)	f=7.68, df=14,168 p<0.001
Present (climb on)	Climb on me 100%	3 (17)	f=1820.37, df=14,28 p<0.001
Present (grooming)	Attend to specific location 99% (Initiate grooming 1%)	27 (156)	f=2384.95, df=14,364 p<0.001
Present (sexual)	Sexual attention to female 49% (Contact 33%)	18 (135)	f=50.80, df=14,238 p<0.001
Punch object/ground	Move away 42% (Sexual attention to male 33%)	6 (8)	χ^2=24.94, df=14 p=0.0352
Punch other	Move away 57% (Stop that 29%)	7 (7)	χ^2=29.17, df=14 p=0.0099
Push	Stop that 78% (Move away 22%)	12 (18)	χ^2=143.82, df=14 p<0.0001
Reach	Acquire object 53% (Contact 20%)	25 (228)	f=30.24, df=14,336 p<0.001
Rump rub	Contact 80% (Follow 20%)	5 (5)	χ^2=45.31, df=14 p<0.0001
Shake hands	Contact 83% (Stop that 17%)	6 (8)	χ^2=68.18, df=14 p<0.0001
Side roulade	Stop that 100%	4 (9)	χ^2=116.00, df=14 p<0.0001
Slap object	Move away 60% (Stop that 13%)	7 (48)	f=10.44, df=14,84 p<0.001
Slap object with	Follow me/Move closer 50%	2 (15)	χ^2=56.89, df=14 p<0.0001

object			
Slap other	Stop that 64% (Move away 32%)	14 (17)	χ^2=100.47, df=14 p<0.0001
Somersault	Stop that 100%	6 (15)	χ^2=193.33, df=14 p<0.0001
Stomp	Sexual attention to male 38% (Move away 29%)	12 (30)	χ^2=48.83, df=14 p<0.0001
Stomp 2-feet	Stop that 50% (Follow me 40%)	5 (10)	χ^2=25.63, df=14 p=0.0288
Tap other	Stop that 42% (Move away 25%)	12 (15)	χ^2=42.00, df=14 p<0.0001
Throw object **	Follow me 100%	1 (5)	χ^2=22.03, df=14 p=0.0781
Gesture meanings: play***			
Arm shake	Play start 81% (Follow me 8%)	3 (13)	f=8.01, df=18,36 p<0.001
Arm wave	Play start 80% (Follow me 20%)	5 (5)	χ^2=4.31, df=18 p=0.999
Dangle	Play start 86% (Play resume 14%)	17 (280)	f=388.05, df=18,288 p<0.001
Drum object palms	Play start 81% (Sexual attention to male 19%)	7 (10)	χ^2=20.07, df=18 p=0.329
Feet shake	Play start 70% (Play resume 26%)	9 (14)	χ^2=21.34, df=18 p=0.263
Gallop	Play start 85% (Move away/ Play change - decrease intensity: 7%)	5 (28)	f=394.3, df=18,72 p<0.001
Hand shake	Play start 82% (Play change - increase intensity 9%, Contact 9%)	11 (11)	χ^2=20.30, df=18 p=0.32
Head nod	Play start 78% (Play resume 12%)	3 (13)	f=134.36, df=18,36 p<0.001
Head stand	Play start 82% (Play resume 18%)	7 (32)	f=90.45, df=18,108 p<0.001
Kick	Play start 74% (Play resume 11%)	3 (13)	f=2.12, df=18,36 p=0.027
Knock object	Play start 83% (Follow me 17%)	6 (6)	χ^2=5.05, df=18 p=0.999
Leg swing	Play start 78% (Follow me 17%)	6 (15)	χ^2=7.88, df=18 p=0.980
Object in mouth approach	Play start 81% (Play resume 19%)	3 (13)	f=14.92 df=18,36 p<0.001
Poke	Play start 72% (Play resume/Travel with me-infant: 11%)	9 (15)	χ^2=76.51, df=18 p<0.001
Pounce	Play start 83% (Play resume 8%)	6 (7)	χ^2=5.94, df=18 p=0.997
Roll over	Play start 68% (Play resume 16%)	5 (28)	f=568.00 df=18,72 p<0.001
Stomp other	Play start 100%	6 (6)	χ^2=7.19, df=18 p=0.989
Stomp other 2-feet	Play start 93% (Play resume 7%)	3 (13)	f=52.32, df=18,36 p<0.001

SUPPLEMENTAL PROCEDURES

(a) *Study site and subjects*

The Budongo Conservation Field Station was established in 1990 in the Budongo Forest Reserve, which lies in the western Rift Valley in Uganda (1°350 – 1°550 N, 31°180 – 31°420 E) at a mean altitude of 1,050 m. The 793-km^2 Reserve includes 482 km^2 of continuous medium-altitude semi-deciduous forest cover [41]. The forest within this site is predominantly secondary forest growth, due to regular logging until 1990.

Observations were made on chimpanzees within the Sonso community during three field periods between October 2007 and August 2009 (October 2007–March 2008; June 2008–January 2009; May 2009–August 2009). At the start of data collection in October 2007, the Sonso study community of chimpanzees consisted of 81 named individuals. Following Reynolds [42] we defined age groups as follows: infants (0–4 years), juveniles (5–9 years), sub-adults (m: 10–15 years, f: 10–14 years) and adults (m: 16+ years, f: 15+ years). Using these categories, the initial group composition was 32 adults (7 males and 25 females), 16 sub-adults (10 males and 6 females), 15 juveniles (6 males and 9 females) and 18 infants (3 males and 15 females). Over the course of the 22-month study, there were 10 deaths or long-term disappearances, 6 immigrations and 5 births, leaving the final total at 82.

(b) Analysis of gestures

Parametric analyses were carried out in SPSS v11, non-parametric analyses were calculated by hand; $\alpha = 0.05$ was required for significance. Means are given ± standard deviation, throughout. All statistical tests were two-tailed.

We maintained a record of the frequency with which a particular individual was observed: where we could choose which of several social interactions to film, we targeted individuals previously sampled infrequently (see [18] for detailed data collection and analysis protocol). Videos were uploaded, scanned for potential cases of gestural communication and these cases edited into discrete clips; any gestures were then reviewed in slow motion and coded into a Filemaker Pro Database. A gesture *sequence* refers to multiple gestures given without pause i.e. <1sec between gestures [19]. A gesture *bout* refers to a series of gestures or gesture sequences, separated by ≥1sec [19], but given by the same signaler and apparently directed at achieving the same outcome.

Only gestures made with evidence of intentional usage were analyzed. Thus, all gesture instances considered in this paper showed one or more of the following: audience checking, where the signaler shows awareness of the recipients and their state of attention; response waiting, where the signaler pauses at the end of the communication and continues visual monitoring of recipients while waiting, without producing any further self- or other-directed activity; or persistence, where - after response waiting, and in the absence of a response that in other cases is taken as satisfactory - further gestures are given, apparently towards the same end. We interpret these gestures as having at least 1st order intentionality [35]. By this we mean that a signaler gestures with the intention of changing the recipient's behavior.

(c) Interpretation of meaning in chimpanzee gestures

The aim of this study was to discover, for each gesture type, the purpose that a chimpanzee intended to achieve by using it: the intended meaning. We followed the method originally established in Genty et al. [10], of deducing the signaler's intended meaning from whatever action taken by the target that appears to satisfy the gesturer: i.e. the target's action that immediately precedes the cessation of communication by the signaler. We refer to this as the *apparently satisfactory outcome* or ASO, to avoid any implication that we had access to internal mental states.

We considered persistence in communication (i.e. continuing to signal after a pause of ≥1s.) to imply the failure of the prior single gesture or sequence, leading to the production of a new gesture or sequence directed towards the same ASO. In this case, the ASO that finally resulted in cessation of communication was taken to apply also to earlier, failed gestures or sequences within the same bout of signaling. To contribute to identifying a gesture's meaning, we also required the recipient's behavior to meet some plausible biological function for the signaler. Given the growing body of evidence against the existence of ape gestures that serve simply to get the recipient's attention [10,18,19,36], we treated as communicative failures those cases where the recipient changed their attentional state but made no further response. Also treated as failures were cases where the recipient: left, if this did not serve any plausible biological advantage to the signaler; physically prevented the signaler from continuing to gesture; aggressively chased the signaler away; or showed no change in behavior or demeanor. We suspected that gestures given when pant-grunting, a submissive vocal signal reliably directed to dominant individuals, might in effect be requests for the high-rank chimpanzee to remain in the same state (rather than show aggression to the subordinate). If so, then a lack of response would be the satisfactory outcome for the signaler: but we could find no way of distinguishing these cases objectively from others where lack of response was simply a matter of failure. We therefore assigned all such cases, along with all apparent failures of communication, to the ASO category 'unknown'.

Our method has limitations. It is limited to the description of imperative demands that require a behavioral change in the recipient; further meanings may be possible in chimpanzee communication, but our approach would not identify them. By using ASOs, rather than charting the context of use of a gesture, we have avoided the spurious ‘flexibility’ of cases in which a gesture with a single meaning is employed across multiple contexts, for example we identify “stop that” as a single ASO although it is employed across many contexts. However, where a signaler’s intended meaning is compatible with a range of ASOs, our method would still tend to exaggerate signal flexibility where several different actions might satisfy the same intention. For example, a gestural request for ‘contact’ might be satisfied by very different actions by the alpha male chimpanzee or by a younger sibling. These variations might themselves be teased apart by considering the relative rank, sex, and relationship of the signaler to the recipient. However, that would require a data set that distinguished the many possible types of signaler-recipient relationships, requiring a much more extensive, long-term study.

(d) Analyzing patterns of meaning: are individual gestures used towards multiple ASOs?

A forced dependency between gesture and ASO could render the data unsuitable for parametric analysis: however, we were able to eliminate this risk by counting all uses of the gesture, including cases where the ASO had been assigned as ‘unknown’, in the total number of cases, rather than just those where it was possible to define an ASO. As expected, most gestures were associated with only one or a few ASOs: a non-homogeneous distribution of variation. We corrected for this non-homogeneity of variation to render the data suitable for parametric analysis (as recommended in

Snedecor and Cochran, see: [43]), as follows. In all cases where the proportion (i.e. uses of a gesture type for any one ASO / total uses of the gesture type, n/N) was equal to 0 or 1, we re-scaled the values. The following substitutions were used: where the proportion was 1, the value was replaced with 1-(1/4N); where proportion was 0, the value was replaced with 1/4N.

We compared the distribution of ASOs between all gesture types with sufficient data for parametric analysis using a 2-way ANOVA. We required a minimum of three different signalers, each with a minimum three cases in which an ASO could be defined, for each gesture type in this initial ANOVA. To remove any effect of pseudo-replication, these data were converted to proportions for each individual. Thus, we calculated the proportion of the total number of uses, by that individual, of that gesture, that corresponded to each ASO (see Procedures in the main paper). As different individuals contributed varying numbers of instances of different gesture types, and thus, the identity of the individuals contributing their data to an analysis of a particular gesture type varied, individual identity was coded and treated as a random factor in the analysis. We then used a planned series of separate ANOVAs for each gesture, with ASO type as an independent variable. For the null distribution to be an effective representation of general gesture use, the data included in the null set should be from as many individuals and gesture types as possible. Therefore, we used the maximum possible set of individuals (all individuals who contributed at least 3 cases of gesture to a gesture type in the parametric analysis) to construct the null distribution, rather than the reduced subset of individuals whose data contributed to each specific gesture type. To address any possible problem from the lack of matched samples, individual identity was again coded as a random variable. In each of these ANOVAS we subtracted this null distribution from the specific distribution per gesture type of each individual who contributed their data; giving us a measure of the extent to which the specific distribution of ASOs for a gesture type deviated from the normal distribution of ASOs in gestural communication. A significant interaction between ASO type and the mean percentage frequency deviation would signify that the distribution of ASOs for the specific gesture type varied from the general distribution of ASOs in the data set. In any case where insufficient data were available to run a parametric ANOVA, a Chi-square test using raw frequencies pooled over individuals was employed, to compare the observed frequency of ASOs for which a gesture-type was used with the 'null' general distribution of ASOs within the data set.

There are two possible risks in the use of chi-square tests for these analyses. Firstly, they do not allow for us to control for any effect of individual identity. We have already established both graphically (see first half of Figure S1) and statistically (see Table S2) that there is no effect of individual identity on signal meaning in the majority of the gestures tested with parametric analyses (12 of 15); and we expect the same to hold true of the remainder of the repertoire. We offer the same graphical support for this consistency of meaning across signalers in the second half of Figure S1, for all gestures analyzed with non-parametric tests. Secondly, by combining data from individuals in the non-parametric statistics, we risk artificially inflating power and thus increase the risk of a type 1 error. However, this would only affect the extent and not the direction of the outcome; and, again, the graphical evidence provided in Figure S1 offers additional support for our interpretation of the meaning of the gestures analyzed through non-parametric statistics.

While employing multiple separate tests for every gesture in the repertoire is not an ideal method, as it runs the risk of false positives, we would still expect only a small proportion of results to be significant through chance alone: in fact, 35 of 36 cases tested showed an association (Binomial: $n=36$, $p<0.0001$).

(e) Playful versus non-playful communication

All gestures included for analysis in this paper showed evidence of signaler satisfaction with a recipient response, one that fulfilled a plausible biological need on the part of the signaler, i.e. where it was possible to record an apparently satisfactory outcome. Amongst the 19 total ASOs (Table S1), 4 were play related: ‘play start’, ‘play change: increase intensity, ‘play change: decrease intensity’, and play-resume’. Gestures were largely analyzed as they were employed *outside* of play, to try to determine their normal meaning (Table S2). Any gesture types only found in play or recorded too infrequently outside of play for the successful attribution of an ASO remained ambiguous: they might simply be rare over all contexts, in which case they must remain unanalyzed; or they might genuinely function mainly in play regulation. For these unassigned gestures, we next examined the entire data corpus, including play. If the gesture was never, or only rarely, used outside of play, but regularly employed within play, we assigned an ASO within play regulation; where too little data was present even after the inclusion of the play data, the ASO remained unassigned.

Five gesture types were seen exclusively within play and were successfully employed 5 or more times: Feet shake, Headstand, Object in mouth approach, Stomp 2-feet other, Stomp other. A further 13 gestures were successfully employed fewer than 5 times outside of play (and were thus not suitable for the non-play analysis in the previous section); but with the inclusion of play data they were used 5 or more times (Arm shake, Arm wave, Dangle, Drum object (palms), Gallop, Hand shake, Head nod, Kick, Knock object, Leg swing, Poke, Pounce, Roll over). All of these 18 gesture types have been assigned an ASO on the basis of the data including play cases (Table S4). For 12 gesture types we observed too few cases of clear attribution of ASO either outside of or including play, for any type of analysis (Bow, Clap, Drum other, Head butt, Hide face, Hit with object, Look, Pirouette, Stiff walk, Tandem walk, Tap object, Water splash) the ASO in these cases remained unassigned.

(f) Statistical analysis of individual use of gesture types

We compared the frequency of the primary ASO (as defined for the whole community in Table S3) with the frequency of all other ASOs combined, in a series of paired t-tests per gesture type. Where the data were not suitable for analysis with a paired t-test, we conducted a replicated G-test of goodness of fit, which allows for the statistical assessment of multiple chi-squares per individual signaler after testing for the suitability of combining them, avoiding the problem of pseudoreplication. In a simple system we might expect that a single ASO would be employed significantly more often than all other ASOs combined. In reality, we found that gestures are used towards 1-3 different ASOs (see Results: What do chimpanzees gesture to achieve) and thus any minor errors, by either the coder or the chimpanzees, are likely to have greater impact on a smaller data set. We therefore re-tested the gesture types to check whether or not the combination of the primary and secondary, or primary, secondary, and tertiary, ASOs (Table S2), was observed significantly more often than the frequency of all other ASOs combined.

SUPPLEMENTAL REFERENCES

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