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Non-verbal behavior as courtship signals: the role of control and choice in selecting partners

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Abstract

In this work, we provide evidence based on direct observation of behavior in encounters of opposite-sexed strangers, that women initiate and "control" the outcome. In the first minute of these videotaped 10-min interactions, neither female "solicitation" behavior nor "negative" behavior is strongly related to professed interest in the man, while female "affirmative" behavior at this stage modulates male verbal output in later stages (4–10 min). Although the rate of female courtship-like behavior is significantly higher in the first minute, it is only in the fourth to tenth minute that the rate of female courtship-like behavior is correlated with professed female interest. We hypothesize that this serves as a strategic dynamic reflecting sexual asymmetry in parental investment and the potential cost of male deception to women. Ambiguous protean behavioral strategies veil individuals' intentions and make their future actions unpredictable. These behavioral strategies may result in men's overestimation of female sexual interest.

Keywords: Mate selection; Initiation of sexual encounters; Courtship; Deception; Affirmative behavior; Solicitation; Negative behavior; Interest; Protean behavior

According to many social non-evolutionary views, the sexes are identical in their behavior, and if sex differences in behavior occur, they are a result of culture-specific learning processes. These learning processes lead further to formation of gender stereotypes. In our culture, socially constructed gender stereotypes allegedly require men to take the initiative in

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initial mixed-sex encounters more often than women (Bruch, Giordano, & Pearl, 1986; Garcia, Stinson, Ickes, & Bissonnette, 1991). If one follows the logic of McCormick and Esser (1983), e.g., one finds that gender relations show an asymmetric distribution of "control behavior" (i.e., who initiates and determines the outcome of opposite sex interactions), which is almost completely norm-governed. According to this view, male-dominated societies allow men to use power in order to obtain sex, whereas women are only allowed to use power in order to avoid sex with unsuitable partners.

Evolutionists have developed hypotheses that can be used to derive predictions about possible sex differences on the basis of asymmetric investment theory. Women having the higher investment in their offspring (Trivers, 1972) have more to lose from making a poor mate choice than men. Evolved female psychology is expected to include mechanisms that could motivate active female choice and strategic control of interactions with male strangers, thus leading towards the most favourable outcome for the female actors.

This does not imply that men are not cautious in mate selection and that they do not choose actively or try to control female approaches. However, because of the asymmetric investment, women should engage in control activities more often than men and should manipulate men relatively more often and with greater subtlety than men would manipulate women. Thus, we would expect a relative difference between male and female "control" behavior in friendly encounters with strangers of the opposite sex.

1. Non-verbal signals in human courtship

In recent years, a repertoire of courtship signals has been established and empirically validated (Grammer, 1990; Kendon & Ferber, 1973; Moore, 1985, 1995; Moore & Butler, 1989; Scheflen, 1965). Although these authors used different settings (single's bars, laboratory, and client–therapist interactions), they all observed similarities in the repertoire of female behaviors in the presence of male strangers, including "come-on-effects" of these signals.

According to Moore's (1985) observations in single's bars, a woman is able to affect male approaches by exhibiting or withholding non-verbal displays: "they can elicit a high number of male approaches allowing them to choose from a number of available men, or they may direct solicitations at a particular man". In this work, a courtship repertoire was established from variation in the frequencies of different behaviors of women in single's bars vs. cafeterias, and an index of this repertoire was positively correlated with male approaches in a single's bar. Moore (1985) also showed that female interest could be assessed if a threshold number of behaviors occurred out of a catalogue of 52 behaviors, but there was no direct prediction of female interest in a man.

Furthermore, Grammer, Honda, Juette, and Schmitt (1999)[1] showed that in the very beginning (the first 120 s) of an interaction, traditional ethological behavior analysis was

[1] This study used the first 2 min from the same experiments which are analyzed in this article. The study used different observation categories and methods. The data in this study were analyzed by K. Kruck.

not able to reveal behaviors related to professed female or male interest in Japanese and in German couples. In this analysis, it was only possible to show, with the help of digital image processing of body movements, that qualitative changes in body movements could predict professed female interest but only to a limited extent. These qualitative changes of movement were detected in the speed, size and number of movements. The analysis also showed that the changes were independent to the content of behavior. The analysis did not assess possible effects of "control" behavior and its effects on subsequent behavior in later stages of the encounter.

In the folk psychology literature on the use of signals in courtship, we find a striking sex difference, which reflects the general relative difference in the mate selection psychology of the two sexes. Women seem to be exquisitely familiar with what occurs during courtship. They can describe in detail how they and other women flirt and pick up men. Even quite successful men seem to have no idea what happens during flirtation (Perper & Fox, 1980). "I just know it works out" was an answer often recorded by Kirkendall (1961) in his interviews with young men. This might be a result of covert female control strategies.

Indeed, women are much better then men in encoding and decoding non-verbal behavioral cues. From the earliest childhood, females exhibit more and more expressive, non-verbal behavior than males do (e.g., facial expressions and touching; Argyle, 1988; Henley & LaFrance, 1984). To quote DePaulo's (1992) review: "Differences in ability, motivation, and spontaneous expressiveness all converge to produce what may be one of the most pervasive and important of all individual differences in the use of non-verbal behavior for self-presentational purposes: Sex differences... [Women's] body movements are more involved and more expressive" (pp. 222–223). If this is the case, it seems reasonable to look for other strategies and ways in which meaning is created in non-verbal exchanges. Grammer, Kruck, and Magnusson (1998)[2] found evidence of female manipulation of the man in a non-intrusive and non-obvious way. If a woman is interested in a man, female rhythmic body movements create "hidden" and highly complex patterns in synchrony with the male body movements. The man perceives changes in her interest but is not able to ascertain their source. The puzzling finding in this work was that female "courtship signals" were not predictive of the particular pattern of behavior observed.

2. Control behavior, deception, and proteanism

In sum, the logic of this line of reasoning about asymmetric investment, women's need to avoid male deception, and women's non-verbal skills, leads to the prediction that women are expected to control men without the men recognizing the manipulation directly. We predict that in an initial encounter, when the goals are unknown (and possibly conflicting), the possibility of deception could play a major role in the interactions of both sexes. If female parental investment and any cue of the possible adaptive loss resulting from bad decision

[2] See above.

making are higher for women than for men, then the possibility of male deception should play a more important strategic role for women than for men.

Male deception about intentions or male quality may be the result of male–male competition and female mate selection standards. The content of male advertisement is controlled through female and male perception of an optimal mate. Indeed, men report that they attempt to deceive women with status symbols (Buss, 1992), whereas women use deception to enhance their physical appearance. Men also use deception more often when they try to attain a short-term sexual relation. These low-investment copulations have been cited more often among men than among women. Men test continuously for opportunities to reduce investment and pursue women (Landolt, Lalumiére, & Quinsey, 1995; Townsend, Kline, & Wassermann, 1995). When comparing them against the background of male deceptive mating tactics, women should have evolved psychological mechanisms that motivate manipulation of men to reveal information about their intentions (what relationship is he seeking if any — short or long term?). This evaluation should take place without male awareness of female evaluation along this dimension (in which case male deceptive efforts might be intensified). A consequence of this strategic female influence is that men should be less aware of being manipulated for the purpose of revealing information about their mating intentions and interests and, indeed believe that it was them, rather than the woman, who initiated and guided the interaction.

Because of these conflicting demands — the utility of advertising and of deception — two strangers who meet find themselves in a delicate situation. On the one hand, interest in the other person has to be communicated in order to signal approachability, while on the other hand, overt signalling could induce and raise the likelihood of deception. Yet, an "overt" approach might be dangerous for the woman in more respects. The approaching man could start to insist on interacting with the woman after she has decided that the information from the man did not suit her aspirations in mate selection; hence, this information can only be transmitted verbally. The woman could run into the problem of getting rid of this man again, or even worse, the man who received positive "come ons" could react aggressively to a subsequent rejection.

The main challenge for communication in such a situation is that as soon as the man perceives some female interest, his tendencies for deception might rise. The strategic solution for the woman would be to influence the man to the extent of his not consciously processing the come-on and thus believe that he himself initiated the approach.

Sabini and Silver (1982) postulated that the essence of initial opposite-sexed encounters is the creation of ambiguity, where both sexes tend to hide their goals and reveal information about possible commitment slowly. Such a situation entails the "communication paradox" (Grammer, Fieder, & Filova, 1997) where intentions have to be communicated without actually revealing these intentions. The effects of such subliminal control strategies could lead to effects which have been described repeatedly for male–female interactions. A number of studies have shown that men perceive women in a more sexualized way than vice versa (Abbey, 1982; Abbey, Cozzarelli, McLaughlin, & Harnish, 1987; Edmonson & Conger, 1985). In their terms, men usually *misconceive* female friendliness and over-rate female sexual interest, whereas women tend to underestimate male sexual interest. This research is usually done with ques-

tionnaires and rating scales or by interviewing subjects who have spent a certain time together. Until today, detailed analyses of behavior of interactions of initial encounters have not been provided.

The existence of such situations naturally leads to the development of "mindreading" with individuals concealing their intentions and deceiving actively (Krebs & Dawkins, 1984). Miller (1997) identifies three possible counter strategies against deception: (a) hiding of intentions (poker face strategy); (b) tactical deception and misinformation (KGB strategy); and (c) adaptive unpredictability (the protean strategy). The latter concept was developed by Chance (1957) and elaborated by Humphries and Driver (1970) who called unpredictable behavior "protean", after the Greek river god who eluded capture by continually, unpredictably changing form. The adaptive logic of protean behavior lies in the fact that animals generally evolve perceptual and cognitive capacities to entrain, track, and predict the movement of other biologically relevant animals such as prey, predators, and potential mates. Such predictive abilities mean that unpredictable behavior will often be favoured in many natural pursuit–evasion predator–prey situations. Usually, hostile animals or conspecifics capable of correct prediction punish predictability. Thus, endowing it with characteristics that cannot be predicted by an opponent can enhance the effectiveness of almost any behavioral tactic. As outlined above, human courtship is one situation where deception and mindreading will play a role as outlined by Miller (1997) who expects a coevolutionary arms race in courtship between social prediction and social proteanism.

However, even if concealment of intentions and ambiguity through social proteanism are created with respect to the goals of interactions, "control" strategies are necessary for managing social interactions in one's favour. We would expect asymmetry in the use of control strategies. The sex, which has the most to lose in an interaction with the other sex, should try to control the interaction to a higher degree in order to get the information necessary for decision making and minimization of costs.

In this view, men and women have different interests, which will find their expression in how they act in encounters with the opposite sex. Questions of who, when, and how interactions with a stranger of the opposite sex are initiated are thus central to any discussion of intersexual interactions and their outcome.

We have studied encounters between strangers because they have numerous advantages. These situations have a high degree of uncertainty. If one of the interactants develops interest in his/her partner, it has to be communicated immediately because none of the interactants knows how long the interaction will last. In such a situation with such a short window of opportunity for courtship, the relevant information has to be conveyed very fast. This may look like a limitation of our approach but "waiting room situations", where people randomly meet strangers, are as natural as any other situation. This type of approach even has an advantage; it offers a wide range of combinations of degree of interest among the participants ranging from rejection to intense interest. If interest is then communicated, further courtship may take place (Grammer, 1990).

Several hypotheses follow from our line of reasoning about behavioral interactions of opposite sex persons who have not previously met.

(1) Women, when confronted with a male stranger, will try to "control" the man's behavior more often than the reverse.

(2) Obvious courtship and "come on" signals will play a role only in the later stages of an interaction when the woman has adequately assessed the man's intentions. In the very early stages, women will show protean behavior, i.e., try to signal interest and disinterest erratically in order to veil their intentions and avoid male tendencies for deception by "blocking" the man's mindreading attempts.

(3) We also can assume that women will try to "control" men non-verbally, because non-verbal behavior is, unlike verbal behavior, non-binding (Grammer, 1992). As the man's goals are unknown to the woman, there is only one possibility when meeting a male stranger: female solicitation should elicit male self-presentation.

(4) Under the pressure of male–male competition and an unknown time for interaction, men will be forced to act in a direct and swift manner. Men should therefore use verbal self-presentation in order to communicate interest in the woman.

3. Method

Male and female strangers (mean age 18.5 years, age range 18–23) were selected randomly from different high school classes visiting the research institute where they met in a "hidden" experiment. They were told that they would participate in a videorating experiment. The experimenter left the room in order to "answer the phone call", thus leaving the dyad alone. This situation is a non-artificial everyday waiting room situation. The experimenter returned after 3 min. In this first 3 min, participants did not know how long they would interact (phase I: data analysis limited to the first minute). Upon returning, the male or female experimenter told the participants that the phone call would take another 10 min but actual interruption took place at the tenth minute (phase II: 4–10 min). During the whole time, they were videotaped through a one-way mirror. One pair of the originally 46 participants who suspected that they were being videotaped was excluded from the analysis resulting in $n = 45$ pairs.

The interactions we used in this analysis are a subset of interactions, which have already been analyzed with regard to laughter by Grammer (1990) with a different method and coding system and with regard to the report by Grammer et al. (1998) within the conceptual framework of interpersonal coordination. After the experiment, participants were debriefed and asked for their consent. None of the participants refused consent. This is a widespread method of obtaining comparable results on the interaction of two people called the "dyadic interaction paradigm" by Ickes, Bissonnette, Garcia, and Stinson (1990).

For the analysis, we used three kinds of data.

1. Self-report. Self-report data included the results of a questionnaire assessment of the subjective evaluation of the situation by the participants at the end of 10 min. Participants rated the physical attractiveness of their partner [Likert scales: 1 (low)–6 (high)] and their level of interest in their partner [Likert scales: 1 (definitely not)–7 (definitely)] with the following statements: (1) I would give my telephone number to the person present if I were asked for it, and (2) I would go out to the cinema with the person if I were asked to. The rank Spearman correlation between these two items was

0.63 for women ($n = 45$, $p < 0.01$, Cronbach's alpha 0.80 for the two-item index), and 0.68 for men ($n = 45$, $p < 0.01$, Cronbach's alpha 0.83). Both items were combined into one index of high and low professed interest in the partner as an independent variable for the determination of non-verbal correlates of professed interest.

2. Non-verbal behavior. Analysis of non-verbal behavior consisted of a microanalysis of the behavior of 45 pairs. The microanalysis of behavior was done on an Apple Macintosh computer running MAC-MAX with a frame-by-frame interactive coding program, developed by the authors. The ratio of time for collection of original material to coding time effort was 1:110 resulting in 865 h of coding for the 45 dyads. Coding was completed for each of the 45 dyads and repeated for each of the 83 movement and speech categories. For the complete catalogue, see Grammer et al. (1998). For the present analysis, only a subset of categories was used: "courtship" signals by women, and for partners, an index of "negative" (rejecting) signalling and an index of "affirmative" behavior. Seventeen movements, which were defined as being courtship signals, were those identified by Moore (1985), Givens (1978) and others as flirtatious or courtship signals (see list of behavioral units, Table 2). Signals of rejection or negative female signals have not previously been described in the literature. There are basically two different strategies to indicate rejection: people can avoid talking to each other, or use specific negative signals for rejection. To define "negative" signals, we used an index (the simple sum of frequencies) of the six behavioral units with the largest negative correlation with participants' professed interest in the other person. Head nods defined "affirmative" behavior. Several studies have shown that head nodding by the listener can positively reinforce a speaker's verbal performance (for a review, see Argyle, 1988). This means that a speaker who watches a person nodding will react by speaking more often and longer. Male and female head nods were coded as "affirmative" behavior only if they took place in parallel to the partner talking. Intercoder reliability for the non-verbal behavior analysis was reported (Grammer et al., 1998) as 0.84 (percentage agreement) for five recorded dyads.
3. Verbal performance. The duration of speech was used as a simplified measure of the participants' verbal performance during the 10-min social interaction. Duration was the sum of each onset and offset of speech for each member of the dyad.

4. Results

4.1. Subjective experience of the situation

The analysis of questionnaires showed that the development of self-reported male interest in the woman depended on how attractive the man rated the woman. Professed interest shows sufficient variation from a minimum of four for men (women: two) to a maximum of 14 (women: 14). With such a range, we can analyze the episodes on a broad spectrum from low interest to high interest. As predicted, professed male interest was correlated with female attractiveness. The more attractive the man rated the woman, the

higher his professed interest ($\rho = 0.37$, $n = 45$, $p = 0.004$, two-tailed). Women did not significantly link their interest in the man with male attractiveness ($\rho = 0.23$, n.s.). Furthermore, the correlation did not differ significantly from those of the men when tested with a method proposed by Sokal and Rohlf (1995). Interest in the partner showed an interesting sexual asymmetry. Professed male interest in women was significantly higher ($n = 45$, Mdn = 8.5 of 14 maximum) than professed female interest in men (Mdn = 6.5, Wilcoxon; $p = 0.0018$; two-tailed). This shows that men, on average, were more interested in women than the other way around, and it suggests that more women are interesting for men than men are for women. This result corroborates the results found by Abbey, McAuslan, and Ross (1998).

4.2. Non-verbal behavior: female courtship signals

In this part of the analysis, we attempted to determine the relationship between female courtship signals and female-reported interest in her partner (Table 1).

Correlations of the behaviors were calculated first for the total duration of the observation period (10 min, Table 1). *Head akimbo* is a behavioral pattern where the hands are folded, the arms are moved up and the hands rest in a position behind the head with the shoulders drawn back. This pattern is interpreted as "look at my body"

Table 1
Female solicitation signals and professed interest in the male

	Spearman correlation with professed female interest			
Signal	Total (10 min)	Phase I (first min)	Phase II (fourth–tenth min)	Author who described signal
Head akimbo	−0.25	−0.20	−0.08	Goffmann (1979)
Primp	0.35*	0.18	0.31*	Scheflen (1965)
Head toss	−0.17	−0.09	−0.13	Moore (1985)
Hair flip	−0.00	−0.13	−0.00	Moore (1985)
Head tilt	0.24	0.22	0.30*	Moore (1985)
Breast presentation	−0.01	−0.06	0.04	Moore (1985)
Palm	0.07	0.01	0.15	Moore (1985)
Head down	0.10	0.01	0.17	Ellis (1992)
Shrug	0.14	0.20	0.18	Givens (1978)
Coy smile	0.34*	–	0.34*	Eibl-Eibesfeldt (1995)
Legs open	0.03	−0.10	0.15	Grammer (1990)
Look through	0.31*	0.09	0.27	Moore (1985)
Short glance	0.51**	0.26	0.19	Moore (1985)
Illustrator	0.28	0.09	0.32*	Moore (1985)
Arms flex	−0.21	−0.16	−0.13	Moore (1985)
Smile	0.13	0.20	0.13	Moore (1985)
Laugh	0.16	−0.01	0.17	Moore (1985)
Total	0.45**	0.19	0.38**	

* Significant at $p < 0.05$, two-tailed.

** Significant at $p < 0.01$, two-tailed.

(Goffmann, 1979), but for our participants, this pattern correlates negatively with professed female interest. *Primp* refers to ordering one's clothes without a visible necessity. In *Head toss*, the head moves down, followed by a fast circular upward move, and then the head slowly returns to the original position. The *Hair flip* consists of the same head movement as *Head toss*, the difference being that here, the hands are used to throw the hair back. Neck presentation is a sideward *Head tilt*, supposedly signalling submission or avoidance of the aggressive effect of the "staring eyes" when eye contact occurs. In *Breast presentation*, both shoulders are moved back simultaneously. In *Palm*, both palms are presented upwards. *Head down* lowers the head and gaze and is also alleged to be a sign of submission in courtship. In *Shrug*, the shoulders are repeatedly moved up and down. *Coy smile* is a smile followed immediately by a turning away and lowering of the head. *Legs open* when sitting is self-explanatory. *Look through* was defined as looking at the other person but not fixating on her or him and looking away immediately; there is no pause between the movement of looking at the partner and looking away from the partner. *Short glance* is directed at the partner for less than 3 s. *Illustrator* is an illustrating hand movement when speaking. In *Arms flex*, one or both arms are flexed at the elbow and held in front of the body. *Smile* is a contraction of the Musculus zygomaticus major and *Laugh* is the same, but with the mouth open and sound is produced.

Only a few patterns showed a significant positive correlation (Primp, Coy smile, Look through, Short glance) with professed female interest (Table 1). This situation does not change much when each of the behaviors was limited to either of the two phases. In order to find out whether there were any changes in the correlations between the two phases, the coefficients were z-transformed and tested with a paired t-test. Overall, there was a significant increase in size of the correlation between phases I and II (t-test, $df = 16$, $t = -3.93$, $p = 0.001$), with a higher correlation between professed interest and total solicitation score in phase II ($r = 0.38$) than in phase I ($r = 0.19$). An index of solicitation behavior (the frequency of solicitation behaviors) for the whole 10-min period was significantly positively correlated ($r = 0.45$) with professed female interest in her partner.

4.3. Entropy and variability of courtship behavior

The frequency of courtship behavior decreased significantly from phase I to phase II. Table 2 shows that most of the individual behaviors increased significantly in frequency from phase I to phase II. This apparent contradiction is solved when we look at the variability of courtship behavior. Variability is the quotient of the numbers of different behaviors performed, divided by the number of all behaviors performed. A maximum variability of 1 would mean that each behavioral act was different. In phase I, variability was 0.39 and dropped in phase II to 0.13. This difference is highly significant (Wilcoxon test, $Z = -5$; $p = 0.000$, two-tailed). This variability could be an indicator of a higher degree of proteanism in phase I.

In order to verify that proteanism could be reflected in variability, an analysis of entropy was conducted. The basis of this analysis is information theory as outlined by Shannon and Weaver (1949). Their approach was refined by Losey (1978) and applied to the analysis of

Table 2
Frequencies of female courtship behavior (n = 45)

	Mean of behaviors/minute (SEM)			
Signal	Total (10 min)	Phase I (first min)	Phase II (fourth–tenth min)	Wilcoxon test Z (p) Phase I < Phase II
Head akimbo	1.04 (1.97)	0.26 (0.95)	0.61 (1.26)	−2.0 (0.04)
Primp	3.98 (3.36)	0.98 (1.47)	2.20 (2.50)	−2.8 (0.005)
Head toss	1.93 (3.77)	0.33 (0.73)	1.11 (2.80)	−2.3 (0.02)
Hair flip	3.15 (5.32)	0.54 (1.28)	2.04 (3.38)	−4.1 (0.0001)
Head tilt	12.87 (9.88)	1.93 (1.88)	8.09 (6.89)	−5.4 (0.0001)
Breast presentation	0.33 (0.63)	0.02 (0.15)	0.17 (0.38)	−2.0 (0.04)
Palm	0.28 (0.72)	0.04 (0.21)	0.22 (0.66)	n.s.
Head down	60.41 (24.76)	7.26 (4.45)	40.96 (16.93)	−5.9 (0.0001)
Shrug	2.85 (7.58)	0.57 (1.26)	1.46 (4.51)	n.s.
Coy smile	0.07 (0.33)	0.00 (0.00)	0.04 (0.21)	n.s.
Legs open	2.26 (3.26)	0.46 (0.72)	1.35 (2.07)	−2.7 (0.007)
Look through	1.78 (2.39)	0.46 (0.86)	0.96 (1.66)	n.s.
Short glance	60.98 (22.39)	0.67 (1.12)	4.37 (3.72)	−4.9 (0.0001)
Illustrator	6.52 (9.04)	0.57 (1.22)	5.00 (7.50)	−4.8 (0.0001)
Arms flex	6.70 (7.09)	0.93 (1.36)	4.22 (5.08)	−4.0 (0.0001)
Smile	10.15 (6.64)	1.41 (1.34)	6.33 (4.35)	−5.7 (0.0001)
Laugh	11.67 (6.80)	1.57 (1.36)	7.26 (4.81)	−5.6 (0.0001)
Total	18.7 (5.4)	18.0 (7.5)	14.3(4.8)	Phase I > Phase II 1.8 (.05)

information content in behavior sequences by Hughes (1978). For this analysis, we developed a computer program implementing the algorithms and source code provided by Press, Teukolsky, Vetterling, and Flannery (1992).

A measure of uncertainty (U) of events is defined as a monotonic increasing function of the number of alternative behaviors available. U then is a logarithmic function of the number of alternatives and it is the expectation of the function $\log P_i$ (the probability of behavior i); it is thus analogous to Shannon's measure of information and:

$$U = -\sum_{i=1}^{i} P_i \log P_i.$$

$U_{\max}$ is the maximum uncertainty possible under a given repertoire. Thus, for a range of n behaviors, $U_{\max} = \log_2 n$. In our case, this is 4.087. Hughes (1978) was able to show with this method that behavior sequences in children's play show higher entropy and thus are more freely variable than in exploration.

In our case, U was calculated for each participant and then the means from the first minute and the last minute of the observation period were compared. The last minute was used because the time range of observation has to be the same; thus, the expected probability of occurrence for each behavior is the same. In the first minute, $U = 1.50$ and in the last minute, $U = 1.08$. This difference was significant (t-test for pairs, $df = 44$, $t = 4.93$, $p < 0.001$). Hence,

the uncertainty in the performance of behavior dropped significantly from the beginning of the encounter to its end.

In the first minute (phase I) courtship behavior was more variable and not strongly related to professed female interest in the initiation of the opposite-sexed encounters. Yet, they seemed to become more strongly related in later stages (“Total” signal phase II; Table 1).

This difference raises the question of how women with low professed interest use courtship signals. In order to answer this question, the female participant’s reports of interest in their male partners were divided into three categories of professed interest. Three groups were chosen because this yielded enough cases for each group. We then compared the low-interest group to the high-interest group. In phase I, women with low professed interest sent 15.5 courtship signals per minute, whereas 19.1 came from highly interested women (Median test, n.s.). The difference was statistically significant in phase II (11.4 for low interest vs. 15.5 courtship signals for high professed interest; Median test, exact probability $p = 0.007$). It would appear that women with low professed interest cannot be discriminated on the basis of their courtship behavior from those with high professed interest in phase I, but can be discriminated by phase II.

4.4. Non-verbal behavior: negative signals

In order to determine a baseline of negative signalling, we calculated an index of the six behavioral categories showing the lowest correlation with professed interest (negative signalling; Table 3). Here, the results of our study contradict the literature on courtship signals. The codes are self-explanatory with the exception of *Deictograph*. This is a simple pointing movement with a stretched-out finger towards an object. Two of the courtship signals, *Head toss* and *Head akimbo*, correlate negatively with professed interest and are thus a part of the index for negative signals for women. Negative signalling seems to be stable throughout both phases for women. It drops significantly for men from phase I to phase II. For negative signalling, there is an interesting sex difference in phase II. Women signal negatively more often in phase II than men do (1.7 vs. 1.1: Wilcoxon test, $p < 0.001$, two-tailed). The overall frequencies of negative signalling are astonishingly low when compared to courtship signals [see Total in Table

Table 3
Spearman rank correlations negative signals with professed interest ($n = 45$, both sexes)

Behavior	Males	Behavior	Females
Roll sleeves up	−0.18	Head akimbo	−0.25
Look around	−0.19	Knees toward body	−0.18
Deictograph	−0.20	Move legs	−0.32*
Palm	−0.19	Cross legs	−0.31*
Close legs	−0.36*	Arms parallel	−0.17
Smile	−0.20	Head toss	−0.17
Index	−0.40*		−0.22

* Significant at $p < 0.05$, two-tailed.

Table 4
Means of behavior categories (SD) and Spearman rank (r) correlations with professed interest in the partner (n = 45, for both sexes)

	Males						Females					
	Total (10 min)	r	Phase I (first min)	r	Phase II (fourth–tenth min)	r	Total (10 min)	r	Phase I (first min)	r	Phase II (fourth–tenth min)	r
Negative signals/min	1.58 (0.81)	−0.40**	2.98[a] (2.2)	−0.25	1.58 (1.0)	−0.40**	1.0 (0.93)	−0.22	1.7 (2.0)	−0.19	1.10 (1.1)	−0.16
Affirmation/min	0.78 (0.8)	0.29	1.26[a] (1.5)	0.12	0.70 (0.81)	0.34*	0.85 (0.7)	0.24	1.24[a] (1.2)	0.16	0.78 (0.73)	0.26
Speech duration, s/min	20.7 (8.8)	0.33*	17.92[b] (8.9)	0.11	21.1 (9.4)	0.36*	21.3 (9.9)	0.23	20.2 (11.8)	0.08	21.7 (10.4)	0.27

[a] Phase I > Phase II, Wilcoxon test, $p < 0.05$.
[b] Phase I < Phase II, Wilcoxon test, $p < 0.05$.
* Spearman rank correlation with interest, $p < 0.05$.
** Spearman rank correlation with interest, $p < 0.01$.

2 (18.7) as compared to total negative signals in Table 4 (1.0)]: the ratio of negative to positive signals (the number of negative signals divided by the number of positive signals) is very low: it was 0.09 in phase I and dropped to 0.07 in phase II, a non-significant change.

4.5. Affirmation and speech

The frequency of nodding was lower for both sexes in phase II than in phase I (Wilcoxon test, $p < 0.01$, two-tailed, Table 4), and there was no significant sex difference. In contrast to non-verbal behavior, the amount of male speech increased significantly from phase I to phase II and only male speech duration correlated positively with male professed interest in phase II. Female professed interest showed no significant relation to female affirmation behavior and speech duration.

4.6. Female non-verbal control

Non-verbal control could be exerted by means of signals, which are not directly linked to sexual signalling. One such signal is affirmation through nodding. This can happen in every interaction independent of who is interacting. Furthermore, there might be other behaviors, which are used in the same manner, but nodding is the only one where we have a theoretical and experimental rationale for the assumed function of nodding in the control of speech flow in social interactions. Affirmation through nodding by a signal sender could lead to a rise in frequency of the receiver talking, but there are several caveats. First, the signal sender cannot nod if the receiver is not speaking. Then, it is not clear if the signal sender nods because the receiver is speaking or the receiver is speaking because the signal sender nods. Even when we extend this to nodding and speaking at different times of the interaction, there could be an interaction between speaking at time 1 and speaking at time 2. The same is true for nodding. Thus, the interactions between speaking and nodding at different times have to be considered. In order to test this, we used the following approach as proposed by Aiken and West (1996).

In the first model (Table 5, model A), male speech in phase II is the dependent variable, while the independent variables were female nodding in phase I, male speech in phase I and female nodding in phase II. Additionally, the three interactions among the independent variables were entered into the regression equation.

The resulting regression model showed that affirmative behavior was significantly affected by male speech in phase I, by female nodding in phase I, by the interaction between male speech in phase I and female nodding in phase I, and by female nodding in phases I and II. Model A shows that male speech duration in phases I and II were significantly and positively associated. Furthermore, males spoke more in phase II in relation to female nodding frequency in phase I. Female nodding and male speech in phase I amplified each other and this interaction facilitated male speech in phase II. High speech scores for men and the frequency of female nodding led to even higher male speech scores in phase II.

Table 5
Results of backward multiple regression analysis (criterion for exclusion: probability of F-value ≥ 0.050)

Model	Trait	Coefficient	Standard coefficient	t	p
Affirmative behavior					
	Multiple $R = 0.650$, $p = 0.000$				
A	Male speech II[a]				
	Male speech I	−3.783	0.594	4.556	0.000
	Female nodding I	460.047	0.410	3.026	0.004
	Male speech I × Female nodding I	1.657	0.320	2.279	0.028
	Female nodding I × Female nodding II	−41.455	−0.319	−2.121	0.040
	Multiple $R = 0.694$, $p = 0.000$				
B	Female nodding II[a]				
	Female nodding I	2.137	0.595	5.259	0.000
Female negative behavior					
	Multiple $R = 0.534$, $p = 0.001$				
C	Male speech II[a]				
	Male speech I	2.953	0.464	3.588	0.001
	Multiple $R = 0.528$, $p = 0.001$				
D	Female negative behavior II[a]				
	Male speech I	0.002	0.419	3.184	0.003
	Male speech I × Male speech II	1.698	0.404	3.065	0.004
Female solicitation					
	Multiple $R = 0.480$, $p = 0.001$				
E	Male speech II[a]				
	Male speech I	3.056	0.480	3.626	0.001
	Multiple $R = 0.283$, $p = 0.057$				
F	Female solicitation II[a]				
	Female solicitation I	0.182	0.283	1.958	0.057

Independent variables (predictors) are listed below. Only significant traits from the final regression equations are reported.

[a] Male speech in phase II — fourth to tenth minute — (male speech II), female nodding in phase II (female nodding II), female negative behavior in phase II and female solicitation in phase II as dependent variables.

Model A: Predictors: (Constant), Male speech I, Female nodding I, Female nodding II, Male speech I–Female nodding I, Female nodding I–Female nodding II, Male speech I–Female nodding II.

Model B: Predictors: (Constant), Male speech I, Male speech II, Female nodding I, Male speech I–Female nodding I, Female nodding I–Male speech II, Male speech I–Female nodding I.

Model C: Predictors: (Constant), Male speech I, Female negative behavior I, Female negative behavior II, Male speech I–Female negative behavior I, Female negative behavior I–Female negative behavior II, Male speech I–Female negative behavior II.

Model D: Predictors: (Constant), Male speech I, Male speech II, Female negative behavior I, Male speech I–Female negative behavior I, Female negative behavior I–Male speech II, Male speech I–Male speech II.

Model E: Predictors: (Constant), Male speech I, Female solicitation I, Female solicitation II, Male speech I–Female solicitation I, Female solicitation I–Female solicitation II, Male speech I–Female solicitation II.

Model F: Predictors: (Constant), Male speech I, Male speech II, Female solicitation I, Male speech I–Female solicitation I, Female solicitation I–Male speech II, Male speech I–Male speech II.

As is the case of male speech, female nodding in phases I and II amplified each other and male speech score in phase II. This suggests the following interpretation. In phase I, the male starts speaking, the female is likely to nod. This leads to higher frequencies of male speech in phase II. Thus, female non-verbal behavior in phase I controls male speech production in phase II.

In order to test whether male speech could determine female nodding and female nodding determine male speech, we tested whether female nodding in phase II could be predicted by male speech in phase I (Table 5, model B), but the only significant predictor for female nodding in phase II was female nodding in phase I.

In order to assess the impact of female negative behavior, we made an analysis of female negative behavior in phase I and male speech in phase II (Table 5, models C and D). In this case, the interactions and female negative behavior in phase II and male speech in phase I were entered into the model. Interestingly, it is only male speech in phase I that had a significant effect on male speech in phase II. When we tested for the reverse effect and female negative behavior in phase II, it was clear that this behavior depended on male speech in phase I. In other words, the women reacted negatively if the man spoke a lot. As we had predicted on the basis of protean theory, solicitation behavior had no effect over time on male speech (Table 5, models E and F).

There remains the question of possible correlations between our criterion variables and the problem of interpreting interaction effects between them. In order to address this issue, we present a correlation matrix among the several criterion variables. Table 6 shows that the dependent variables we used in the regression equations are somewhat correlated.

We have considered several ways for a possible solution (e.g., structure equation modelling for a more causal interpretation of our argumentation) and finally decided to use the presented multiple regression model to clear up the problem of having seemingly independent tests of multiple correlated predictors. The analysis of our observations shows that behavior remains rather constant during a particular time span. Thus, we assumed that alternative methods, like causal modelling, did not meet the needs of our argument, as these other models require greater independence between the

Table 6
Spearman rank correlations of dependent (criterion) variables in the final regression equations ($n = 45$)

	Male speech II	Female nodding II	Female negative behavior II	Female solicitation II
Male speech II	–	0.35*	0.25	0.29*
Female nodding II		–	0.19	0.35*
Female negative behavior II			–	0.52**
Female solicitation II				–

Male speech II = Male speech in phase II — fourth to tenth minute, Female nodding II = Female nodding in phase II, Female negative behavior II = Female negative behavior in phase II, and Female solicitation II = Female solicitation in phase II.

* Significant at $p < 0.05$, two-tailed.

predictor variables than is the case. Furthermore, such an approach would generate artifacts in the interpretation of interaction effects.

5. Discussion

Interactions between strangers, especially those between the two sexes, seem to be governed by specific rules. Our results, like that of other researchers, suggest a general sex difference in the professed interest in the other sex. Men are more interested in women than the other way around. Women seem more reluctant than men to make contact. Our second aim was to generate predictions from evolutionary-based meta-theories which predict behavioral tendencies under a wide range of motivational factors.

The main methodological implication of this study is the utility of the concept of proteanism in uncertain high-risk social situations. After performing many types of behaviors, women seem to move to a more consistent repertoire at the end of the encounter. Furthermore, women seem to exert more active control over male behavior: men produce more verbal revelations than women, and the quantity of male self-presentation varies with the female's behavior (predictions 1, 3, and 4, Section 2). This is suggested by the fact that there was a clearer dependence of male behavior on the preceding female acts than vice versa. We found that women solicited male verbal reactions actively and that female negative behavior was influenced by male verbal behavior. In addition, female engagement in verbal interaction did not necessarily signal interest.

Many theories assume that the sexes are essentially equal in their behavioral propensities and that learning processes lead to social stereotypes that compel men to take the initiative in initial mixed-sex encounters more often than women. We find that the women themselves take control by sending subtle signals.

To our knowledge, this is the first time that these effects have been supported with quantitative analyses of observational data. Our results support the hypotheses that sex differences are present and that they follow the direction predicted by our evolution-minded hypotheses: women try to elicit information from men and try to avoid the possibility of deception.

When the situation is highly uncertain and time is limited, both sexes start signalling immediately. There is no direct and strong initial relation between interest and signalling. Interestingly, women use signals described in the literature as solicitation signals irrespective of their professed interest.

Women with low and with high professed interest both send the same amount of solicitation signals, but only highly interested women maintain the rate in phase II. This view is underlined by the positive relation between female interest and an index of solicitation in phase II (Prediction 2, Section 2). This interpretation is strengthened by the correlation between affirmation and male speech duration. Female affirmation (*Head nod*) seems to amplify male speech production. This does not merely involve a simple feedback in which affirmation triggers male speech production, which in turn causes female affirmation. Rather, women appear to control male speech production through the use of non-verbal behavior. This is consistent with our proposed strategy theory, which holds that women try to elicit

information from the man in order to make a decision. In the first stages of the contact, women showed higher variability in their courtship behavior. This fact could be explained by different reasons: either women behave in a protean way and send signals independent of their interest, or women signal a complete repertoire and try to find out which behavior modulates a man's response. In this view, every pair would develop its own non-verbal code for courtship. However, this explanation is not sufficient to explain the fact that there was no clear and distinct negative relation between solicitation behavior in the first stages and an absence of professed interest. It would not be necessary to signal solicitation behavior, in order to establish a common communicative repertoire, if no interest is present.

We predicted that women would tend to use covert strategies in order to avoid male deception. At a first glance, this does not seem to be the case. Rather, decisions are made quite early in an encounter as evidenced by a high correlation in behavior between the two phases. Indeed, we know that first impressions are made very quickly and that those impressions are generally quite accurate (Ambady & Rosenthal, 1992). Although decision points can be very early, people still have to verify this first impression. This puts the signal sender in a difficult situation: if the sender is interested but needs verification of information, he/she has to be deceptive. In order to avoid detection in such a case, the signal sender (the woman) should start signalling positively and try to veil her intentions. However, deceit would select for efficient mindreaders who try to find more subtle cues, but we have experimental evidence that men are not as skilled as women in deciphering non-verbal cues (Argyle, 1988). It seems possible that men ignore female solicitation in early interactions. Another male strategy would be to probe the signaller and demand evidence from additional signals, but we currently have scarce evidence for such a strategy. The protean strategy would also explain the fact that men continuously overestimate female sexual interest which seems more likely than mindreading a protean woman.

An objection against a protean/deceptive explanation is the possibility that women might test out men and then find out that the man is not interested and accordingly adjust their professed interest to disinterest. If professed interest is the same as genuine interest, then others present should be able to detect this.

Our results on solicitation behavior replicated Moore's (1985). Moore also found that an index of only 10 out of 52 courtship behaviors could predict "come on" effects. Although Moore did not make this point, such a finding of any 10 of 52 behaviors would result in 1.6×10^{10} different signal combinations. In general, non-verbal signals are ambiguous and it could be the quality of motor performance that denotes interest in such a situation as shown by Grammer et al. (1999). Moreover, if the combinations of different signals have to be taken into account by the observer, the complexity of the task becomes very challenging. On the same data, with different analytic methods, Grammer (1990) showed that female interest can be depicted from combinations of several signals performed simultaneously, i.e., laughter combined with body posture. Thus, the general ambiguity of non-verbal signalling could lead to the variability in female signalling. There are other possible explanations for the deployment of solicitation signals by women, including emphasis on gender role identification, and enhancement of their attractiveness to men. Women typically take longer than men to evaluate man's acceptability. One possible interpretation of our results is that the women were uncertain and thereby signalled conflicting cues. Shyness could be coupled with age.

Our participants (18.5 years) could be considerably younger than the participants from other studies who where observed in bars and nightclubs.

Furthermore, cultural variations in the incidence and dynamics of solicitation behavior are likely. Most of the researches cited in this paper were carried out in the United States or Canada. Grammer et al. (1999) report the same repertoire for Japanese as Germans, but lower rates of solicitation behavior with opposite-sexed strangers in Japan than in Germany.

There are also many known methodological problems in our study. The first problem is sample size. The negative findings can be a result of our small sample size, because the statistical power (the ability to detect true effects) for the analysis of our data was low. Other speculations for the discrepancy between signalling solicitation and professed interest are that the 10-min encounter with analysis based on 1 min was too short. Yet, the question remains as to why there were more courtship signals in the very beginning than later stages in the 10-min encounter. Also, the situation could be artificial, although this is not actually the case. A waiting room situation is an everyday situation and interest in the other sex can occur in any situation, so people should be familiar with this kind of encounter.

One of the surprising facts in this study was that women, if not interested, do not send clear rejection signals. Thus, the man is likely to feel that he himself has started the interaction. In fact, women show affirmation, engage in verbal exchange, and send sexually explicit signals without having much interest in the man.

Female negative behavior is performed with astonishingly low frequencies. This can be interpreted as a result of the woman's attempt to prod men to reveal information about themselves. Negative signals were never strongly related to female interest at any time of the interaction. Negative behavior was apparently a reaction to male speech production: men who produced too much in phase I were highly likely to encounter female negative behavior later.

Possible goal incompatibility in encounters between complete strangers has great potential for conflict for both sexes. Cultural norms could function to prevent people from signalling negative emotions too directly and thereby reduce conflict. This argument is consistent with our findings of low rates of female negative signals. The necessity for manipulation, and for information, along with possible deception, leads to a highly ambiguous situation. Here men might well perceive female behavior as an aggressive "come on", especially in light of missing negative signals. In solving this dilemma, women attempt to create an ambiguous situation by using non-verbal behavior, while simultaneously trying to control the man. As soon as the highly discriminative woman determines that the man — who is under the impression of being accepted — is not suitable, she does not clarify the situation. This behavior can be interpreted as being "aggressive" in the sense that it manipulates men's behavior and their social perceptions.

The results of this analysis show many inconsistencies, but also make clear that the concept of proteanism in situations with high social risks might be useful in future research. Further studies should entail ratings by third party participants on interest and on the possible perception of interest. We would predict from protean theory that neither men nor women should be able to predict female interest from the very early stages of the encounters. Other directions for future research involve comparisons of the social interactions in similar encounters in different contexts and with persons varying in age and marital status.

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