

The Role of Touch in Facilitated Communication¹

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Imagine that one day a nonverbal autistic child suddenly starts to type messages, such as "I am not retarded," using a computer keyboard while being touched by an assistant. Facilitated communication (FC) appears to create this miracle around the world. To understand how this works, experiments were conducted involving a "telepathy game" using a rod with an attached strain gauge. A force from the assistant, which controlled what was spelled through physical support, was measured. It was thus completely possible for any message to appear to be typed with FC regardless of the autistic child's actual knowledge or language ability.

Accumulated evidence from controlled studies of facilitated communication (FC) suggests that subjects with autism and other disabilities were unable to answer questions when their facilitators did not hear questions, could not know the answers, or did not look at the letter display, while most responses were correct when facilitators knew the expected responses (see summaries: Green, 1994; Jacobson, Mulick, & Schwartz, 1995).

The most puzzling and unusual aspect of FC that appeared in these studies using double-blind procedures was that the subject's responses were appropriate to the question asked of their facilitator when facilitator and subject were asked different questions (Cummins & Prior, 1992; Hudson, Melita, & Arnold, 1993; Klewe, 1993; Shane & Kearns, 1994; Smith, Haas, & Belcher, 1994; Wheeler, Jacobson, Paglieri, & Schwartz, 1993). This phe-

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nomenon allows only two possible explanations. One explanation offered by some FC proponents is that subjects had telepathy or something like extrasensory perception (ESP) (cf. Cummins & Prior, 1992; Green & Shane, 1994; Shane, 1994). However, unlike the so-called ESP, this appeared to occur between two people through touch (hereafter referred to as “pseudo-ESP phenomenon”). Why? The most plausible alternative explanation is that facilitators were doing something to control FC messages without realizing it themselves. What are they doing? To understand the role of facilitator in the pseudo-ESP phenomenon, a series of experiments simulated and analyzed this phenomenon with an autistic child and non-disabled people.

EXPERIMENT 1

One participant in Experiments 1 and 2 was a girl with autism, J. She was born in 1981. Since 1987, she has been “communicating” by using the 50-sound Japanese syllabary and a word processor with physical support from assistants (“facilitators”), for example, family members and school-teachers. While J’s communication is very similar to FC, which was developed by Crossley (1992), it was used independently of and without any knowledge of FC. When J and an assistant were touching, the words the assistant was thinking often appeared to be typed by J. This phenomenon was confirmed by several assistants and interpreted as an extraordinary case of telepathy (pseudo-ESP phenomenon).

To study how this illusion was created, a “telepathy game” was played in which the assistant was instructed to send messages (by thinking them) to J (the “receiver”).

Method

Subjects

In 1993 when this study began J was 11 years of age. J’s behavioral characteristics were as follow: (a) perseveration; (b) no spoken language; (c) no bodily paralysis; (d) normal hearing; (e) autistic characteristics; (f) clumsiness. In addition, J was unable to take any intelligence tests, because she randomly pointed to answers or often refused to take tests without physical support. J’s independent communication consisted mainly of vocalization (i.e., crying, screaming) and a few vague gestures.

Items written on the word processor with physical support ranged from daily conversation to letters, poetry, essays, foreign language, and arithmetic. The method of physical support varied depending on the assistant and the task. In some cases J gripped, with her right hand, the pointing finger of the assistant from above. In other cases, the assistant touched the back of J's right hand with one finger, or rested his/her hand on J's shoulder or head, or squeezed J's right sleeve. In some rare cases, when the assistant touched J's left hand, J moved to strike the key with her left pointing finger, but ordinarily she struck it with her right index finger. Independently, she could press a key randomly or one by one from left to right, but could not type any messages.

The other subject in Experiments 1 and 2, the assistant, was J's mother. She was the first person who started to "communicate" to J with physical support and has continued to support J since 1987. She had no knowledge of, no experience in, and no training of any special education, to say nothing of FC.

Procedures

Telepathy games were conducted under various conditions, defined by the nature of contact between the sender (assistant) and receiver (J) as follows:

Direct Contact. (a) Right hand (palm): J gripped the right index finger of the assistant from above with J's right hand. (b) Right hand (back): the assistant touched the back of J's right hand with her right index finger. (c) Right forearm: the assistant held J's right forearm from above. (d) Both shoulders: the assistant rested both hands on the shoulders of J. (e) Left hand: the assistant gripped the left hand of J with her right hand.

Indirect Contact. Plastic rods and ribbons of varying lengths (15, 30, and 40 cm) were used. The rods were curved at both ends and one of the curved ends was attached to the right little finger of J, while the assistant held the other end. In the case of the ribbon, one end was tied to the right little finger of J, while the assistant held the other end.

The assistant randomly selected and looked at 1 card from a deck of 52 cards excluding the joker. J was instructed to "guess" and "type" the number and suit of the card without looking. J responded using her customary word processor with the assistant's physical support. Before this experiment, it had already been confirmed that when J looked at 1 card from a deck of 52 cards and the assistant did not know the card, the correct answer (the card's number) was typed with the assistant's support only 1

time in 10. This was not significantly different from the chance accuracy of 1/13.

During direct and indirect contact conditions, the assistant was positioned diagonally behind, directly behind, laterally, or otherwise relative to J, according to testing conditions. The movements of J's hand and part of the upper part of her body were videotaped during the trial by a camera located diagonally above the keyboard. Electromyography (EMG) of J's right forearm, and the assistant's right arm and shoulder was measured. However, the EMG data did not clearly show the role of the assistant (Kezuka, 1993). Hence, in this paper, only EMG data on J's right forearm was used as an additional index confirming the striking of a key. J's spelled responses were evaluated on these VTR and EMG data. Interobserver agreement between an independent observer and the author was 100%.

Results and Discussion

The results of this experiment are summarized below and in Table I. (a) There were few errors in each condition. J's performance was unusual because three successive correct responses for a number has a probability of 0.00045. (b) The most difficult game was when a loose ribbon (30 cm, 40 cm) was used. Incorrect answers appeared for the first time and J expressed sounds and movements of displeasure. Trial time also slowed. (c) Judging from the spelling errors, the next most difficult game was when the assistant gripped J's left hand (not the hand that struck the keys). Judging from trial time, however, the next most difficult game was when the assistant touched the back of J's right hand with only her right index finger. (d) Indirect contact with J via a short rod produced the fastest trial time and good performance.

From these results, it was inferred that what was transmitted from the assistant to J was not words, but physical force. That is, the assistant applied a force to exercise control over J's pointing responses, creating the illusion that J was typing.

The observed behavior of J during the experiment was as follows: If the contact conditions changed, J would change the position of her body or arm, or pull the word processor close to her. For example, if the assistant's hands touched J's shoulder, J would lift her right elbow and keep her shoulder, elbow, and wrist joints in a fixed position. These movements were inferred to be adjustments by J to receive the full weight of the assistant's hand on her shoulder, the force of which passes down J's arm to her right hand, with which she strikes the keys. It has been pointed out that there are 8 degrees of freedom in the arms at the joint level (shoulder

Table 1. Performance of J Depending on the Form of Physical Support

	Direct contact				Indirect contact			
	Right palm	Right back	Right forearm	Left hand	Rod (15 cm)	Rod (30 cm)	Rod (40 cm)	Ribbon (15 cm) (30 cm) (40 cm)
No. of trials	3	3	3	4	2	2	3	3 1 4
Error (typing wrong number)	0	0	0	0	0	0	0	0 1 1
Error (typing wrong suit)	0	0	0	0	0	0	0	0 0 1
Total of spelling errors (suit) ^a	1	1	3	6	0	0	2	0 1 12
Trial time of the first trial (sec) ^b	21	43	21	23	13	7	26	44 72 84
Average of trial times (sec)	21	27.3	22.7	20.8	14.5	7.5	15.3	26.3 72 37.8

^aNumber of misspelled letters (*kana*, a Japanese syllabary) for all trials (e.g., *mututuba* = 3 correct letters and 1 misspelled letter, club in English).

^bThe time from when the first key of the number was struck to the time when the last key of the suit was struck.

= 3, elbow = 2, wrist = 3) (Jordan & Rosenbaum, 1989). Under contact conditions using a rod, the end of the rod was attached to J's right little finger, so that the force acted directly on her right hand. This meant there was no interference resulting from the degree of freedom of the joints other than finger joints, making it possible for the assistant to accurately exercise control. Conversely, when the assistant gripped the left hand, the degree of freedom of both arms through the torso became relevant, making the task more difficult.

When a video of the experiment was observed one frame at a time (30 frames per second), it was noticed that J made several fast, repeated movements above the keyboard before pressing the keys. The pattern of these movements consisted of J lowering her fingers at a diagonal and then lifting them again, and of aiming them in a different direction, lowering them and then lifting them. Also, just before lowering her fingers to strike, a slight lateral movement to the next key was added, constituting two stages of preparation. It was inferred that this movement of the fingers at the keyboard indicated that J searched for a direction in which the restraining force of the assistant was not applied. In short, it appeared that J had learned to scan the keys with her pointing finger until slight changes in force from the assistant signaled her to drop her finger to the letter below.

EXPERIMENT 2

To test the inferences from Experiment 1, it was necessary to clarify (a) whether the assistant was actually exercising a force upon J; and (b) what movements of J were related to this force.

Method

Apparatus

An apparatus was constructed to detect a force between two people when they touch one another (see Figure 1). The striking of a key by the subject while touching the facilitator was too complex and not conducive to measurement. Accordingly, this apparatus was used to limit an ordinary three-dimensional movement to a one-dimensional movement. The contact between the two persons was through a rod with a strain gauge attached. The level of shear strain was measured by a dynamic strain amplifier. This method made it possible to detect, as strain, very slight force applied to

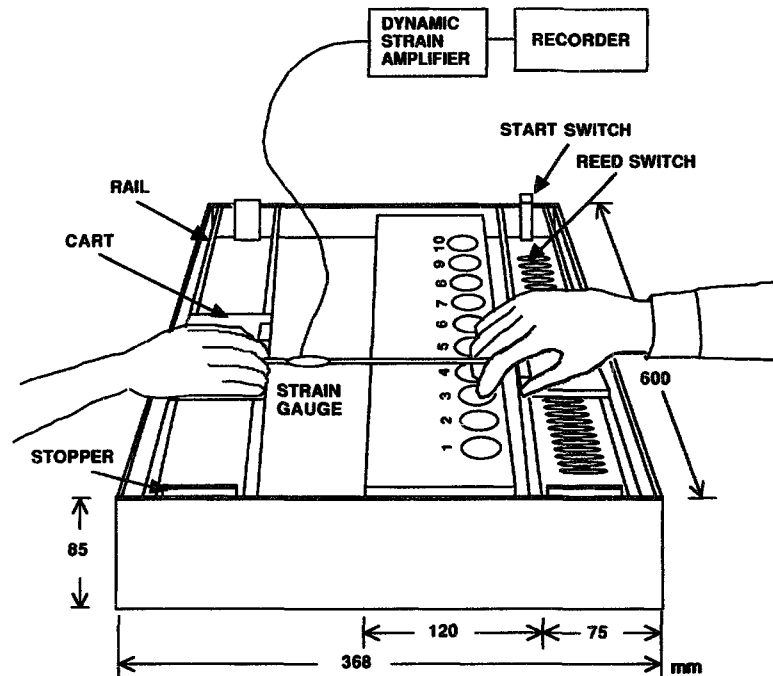


Fig. 1. Apparatus used in Experiments 2-5.

the rod. Figure 2 shows an example of measurements recorded with this apparatus.

A keyboard with keys numbered 1 through 10 (25 mm in diameter) was arranged laterally and placed at the receiver's (J's) side. Rails on which a cart was able to move were laid alongside the keyboard. Similar rails and cart were also arranged on the sender's (assistant's) side. Stoppers were installed on both ends of the rails to prevent the cart from derailing. A square-shaped aluminum rod, 5 mm on one side and 35 cm in length, crossed between the two carts and was lightly fixed from above by a sponge. A strain gauge was attached to one side of this rod.

The sender and receiver were seated facing each other. Each put a hand on his/her respective cart, with the rod between his/her fingers, and moved the cart along the rails. The receiver struck the keys. If the movements of the two persons were synchronized, the values of the strain were nearly zero and virtually fixed. If, however, imbalance of the movements occurred, a significant change in the strain took place. A microswitch was

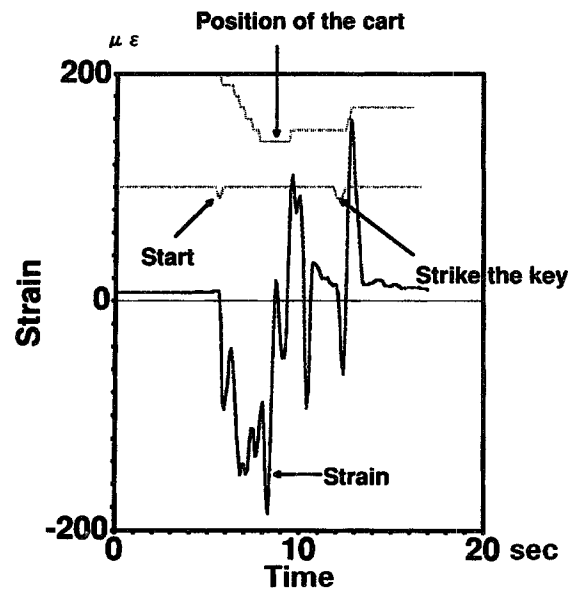


Fig. 2. An example of measurement.

attached to the starting point (Key 10) and each number key. Several reed switches were attached beneath the cart on the receiver's side (A magnet was attached under the receiver's cart.) The moment a key was pressed, the position of the cart (= the position of the receiver's finger striking the key) and the strain value were recorded simultaneously (see Figure 2).

Procedures

The task and subjects were the same as in Experiment 1. Cards numbered 11, 12, and 13, however, required that keys be pressed twice. Accordingly, these cards were removed, resulting in a deck of 40 cards. The assistant was instructed merely to set her hands on the cart without intentionally moving them. J was instructed by taking her hand to show her what she was expected to do. She was able to place her hand on the cart, move the cart, and press the keys randomly without assistance.

Results and Discussion

The results of the second experiment are shown in Figure 3, which shows the key position at which the change in strain became significant

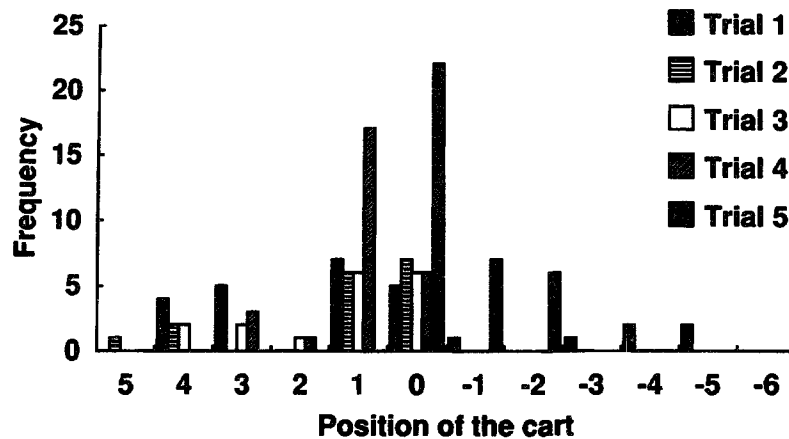


Fig. 3. Frequency of extraordinary differential values of strains during the trial.

during the trial (Kezuka, 1994). The period from the start of the trial until just before the key was struck was set as a single analysis unit, and the strain curve during that period was differentiated. The overall average and standard deviation were calculated from the differential values for each one-tenth second. The frequency of extraordinary differential values outside 1 standard deviation is displayed for each cart position (using the number key corresponding to the position of the finger striking the key). However, the position of J's finger during Trials 2, 3, and 4 slipped one past the position of the cart. The horizontal axis in Figure 3 shows the correct key position as zero, and indicates the gap from that point. The starting position was always number 10. Accordingly, plus indicates responses to keys before the correct key and minus indicates responses to keys after the correct key in the numerical sequence.

The results of Experiment 2 can be summarized as follows: (a) Five trials were conducted and correct responses were obtained for all five (Recall that the assistant knew the expected answers). (b) On all trials, excluding the first, J's fingers left the starting point (positioned at the 10 key) and moved one or two keys away from the correct key before returning to the correct key and pressing it. In Trial 4, when returning, J's fingers moved back past the correct key in the opposite direction, before returned to it; J's fingers went back and forth past the correct key before pressing it (see Figure 3). (c) Differentiating the strain curve and considering that value as an index of the force gradient showed that the change of force was greater in the vicinity of the correct key in all five trials. This indicated

that the movements of either J or the assistant changed in this vicinity. If, in fact, J herself knew the answer, it seems there would be no need to move away from the correct key before returning to it. It therefore is likely that the assistant, knowing the answer, moved in such a way as to restrain the movements of J. These results showed that even if the assistant was not overtly applying force, she did in fact apply a force that restrained the movements of J in the direction away from the correct key.

The next problem was to discover the extent to which this conclusion could be generalized to other cases. FC advocates admit that there are cases in which facilitators guide the movements of their partners (Biklen, 1990; Crossley & Remington-Gurney, 1992). Accordingly, there will be arguments that, in the case of J, the problem lay with the skill of the assistant.

To address this issue, the same telepathy game experiments, using the same apparatus shown in Figure 1, were conducted on nondisabled people of differing ages and genders. The purpose of these experiments (Experiments 3–5) was twofold: (a) to determine whether pseudo-ESP phenomena through touch occurred in nondisabled people; and (b) if, in fact, this phenomenon could be confirmed, whether or not it could be explained by motor control. If viewed on their own, separately from the other movements of J, another explanation of the results shown in Figure 3 is possible—that J simply adjusted her movement in response to other sensory cues from the assistant. FC skeptics argue that subtle visual, tactile, or pressure cues (e.g., Cummins & Prior, 1992; Green & Shane, 1994) are provided by the facilitator. This hypothesis can be divided into the visual-cue hypothesis and the pressure-cue hypothesis. According to the sensory-cue hypothesis, the facilitator gives a cue, but does not directly exercise motor control over the subject by force. The second purpose of these experiments, then, was to test these rival hypotheses and to determine what factors were necessary and sufficient to control FC responses.

EXPERIMENT 3

Method

The following two conditions were established to achieve the first purpose listed above:

Contact Rod. The receiver and sender achieved contact through a rod. Each played his/her hand on their respective cart and they moved together. The receiver struck the keys. This condition was identical to Experiment 2.

Noncontact There was no rod between the receiver and sender. The sender left his/her hand on his/her own cart in the start position, not moving the cart. Only the receiver moved and struck the key.

There were total 32 subject pairs, consisting of parent-child ($n = 7$), friends ($n = 17$), sisters ($n = 1$), colleagues ($n = 5$), and a married couple ($n = 2$).

The tasks and procedures were basically the same as for J. One difference in procedures was that subjects made 10 responses per card. (In J's case, one response per card.) One session consisted of 10 responses. For each pair, 5 contact-rod sessions were conducted, followed by 5 noncontact sessions. Correct answers were given to the receiver after each session finished. No words were spoken until the end of a session.

The sender was instructed to hope strongly for the correct answer; to not intentionally move his/her hand, and to merely let it rest on the cart and follow the movements of the receiver; and to gaze toward the receiver's hand on the cart. The receiver was told that he/she could move his/her cart back and forth from the starting position until he/she struck a key, and that he/she should return his/her cart to the starting point after striking the key.

Results and Discussion

Responses were categorized into three types: CR: correct responses; CCR: Responses in which the keys next to the correct key were struck (Keys 1 and 10 were end keys and therefore had "next keys" on only one side); and ER: Incorrect responses in which other keys were struck.

The subjects were divided into the following three groups based on the significant difference level ($p < .10$) between contact-rod performance and noncontact performance (the total CR, or the total CCR and CR for each pair).

Successful Receiver Type I (SRI). Receivers with significantly good contact-rod performance (Figure 4). There were 11 SRI pairs. They accounted for 34.4% (11/32) of all subject pairs. In contact-rod Trials 3, $\chi^2(1) = 5.682$, $p < .05$, and 8, $\chi^2(1) = 3.991$, $p < .05$, the percentage of this group's total CR was significantly different from the level of chance (chance = 10% correct). The mean proportion of CR for all trials was 20.9% for contact-rod trials and 7.8% for noncontact trials.

Successful Receiver Type II (SRII). Receivers with significantly good noncontact performance (Figure 5). There were 5 SRII pairs. They accounted for 15.6% (5/32) of all subject pairs. In noncontact Trial 8, the percentage of this group's total CR was significantly different from the level

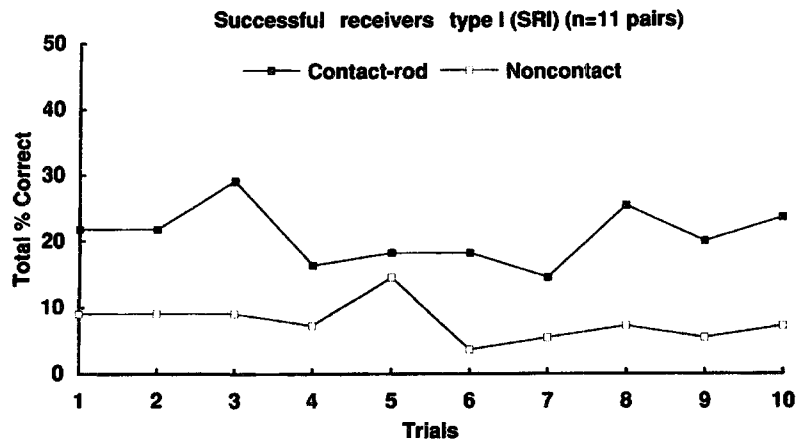


Fig. 4. Total percentage of correct responses (the total CR) for Trials 1 through 10 for successful receivers type I (SRI).

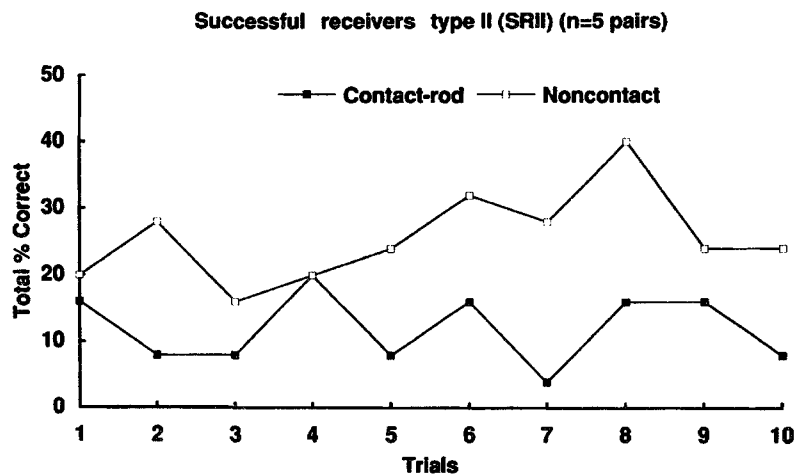


Fig. 5. Total percentage of correct responses for successful receivers type II (SRII).

of chance, $\chi^2(1) = 5.092$, $p < .05$. The mean proportion of CR for all trials was 12.0% for contact-rod trials and 25.6% for noncontact trials. When four of the SRII pairs wore a blindfold in the noncontact condition, their ratio of correct answers fell to the chance level (Figure 7). These results suggest that visual cues may play a role in their performance.

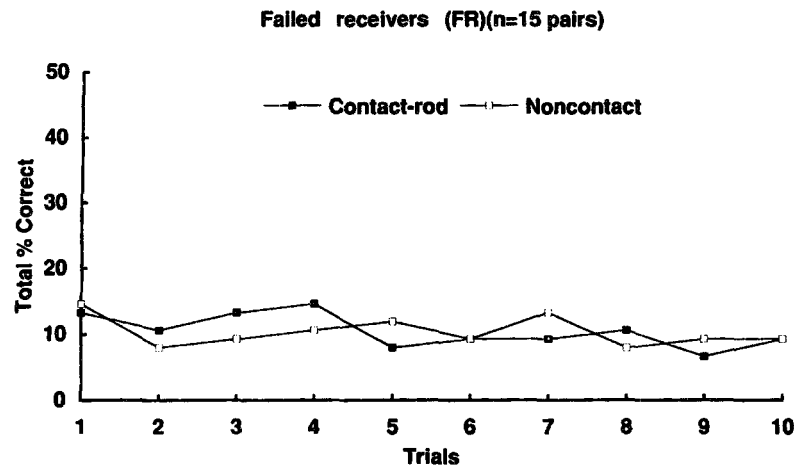


Fig. 6. Total percentage of correct responses for failed receivers (FR).

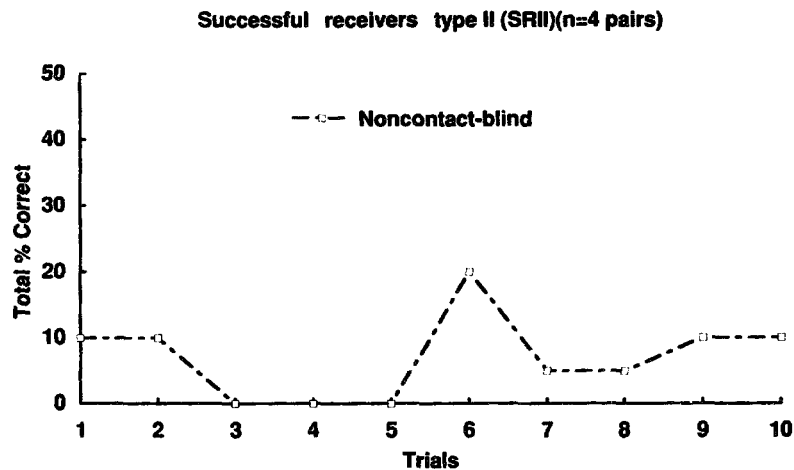


Fig. 7. Total percentage of correct responses on noncontact-blind condition for four of the SRII pairs in Experiment 3.

Failed Receiver (FR). Receivers with no difference in performance under varying conditions (Figure 6). There were 15 FR pairs. They accounted for 46.8% (15/32) of all subject pairs. In each trial and for each condition, the percentage of this group's total CR was at chance levels. The mean

proportion of CR for all trials was 10.5% for contact-rod trials and 10.4% for noncontact trials.

One pair performed exceptionally well under both conditions. This pair's percentage of total CR and CCR was 68% in contact-rod and 64% in noncontact trials. The receiver reported that she had learned to use visual and tactual cues from the sender during the trials. This pair was not included in any of the above three groups.

SRI accounted for 34.4% of all subject pairs. These results were thought to be sufficient to conclude that the pseudo-ESP phenomenon through touch was confirmed in nondisabled people. The rationale for this conclusion is (a) FC advocates have pointed out that some people were unable to act effectively as facilitators despite their aspirations (Biklen, 1990). Consequently, it was not necessary that all subjects succeed in verifying the phenomenon and show its relevance to FC. (b) The five sessions (15 to 30 minutes in length) were too short for some subjects to master the technique. J received physical support for more than 6 years. Many other successful FC users and their facilitators have experience ranging from several days to several years (e.g., Biklen, Morton, Gold, Berrigan, & Swaminathan, 1992; Eberlin, McConnachie, Ibel & Volpe, 1993). Consequently, it can be expected that the number of pairs moving from FR to SRI would increase if a sufficient number of practice trials were accumulated.

EXPERIMENT 4

Conditions were established to answer the second question: What factors were necessary and sufficient for the pseudo-ESP phenomenon, that is to say, for senders to control the responses of receivers through touch?

Method

The following two conditions were established to test the sensory-cue hypothesis, in the context of a telepathy game as in the preceding experiments:

Contact Rod-Blind. To test the visual-cue hypothesis, the receiver was blindfolded. It was predicted that the receiver would fail under these conditions if in fact visual cues were being used. This condition was the same as the contact-rod condition except that the receiver wore a blindfold during the trial.

Contact Ribbon. This condition was set to test the pressure-cue hypothesis. Both ends of the loose ribbon (100 cm) were tied to the fingers of the sender and receiver, which were placed on the cart. The ribbon was kept long enough to remain slack during the trial. This prevented pressure from being applied to the receiver if the sender moved. It was predicted that the receiver would fail under these conditions if in fact pressure cues were being used.

Seven of the SRI pairs in Experiment 3, friends ($n = 4$), sisters ($n = 1$), colleagues ($n = 2$), also participated in this experiment. In Contact-ribbon condition, however there were only five subject pairs.

Results and Discussion

The results are shown in Figure 8. The performance for *contact-rod blind trials* (mean percentage of CR for all trials: 29.7%) was slightly better than for contact-rod trials ($M = 24.9\%$). The percentage of total CR for Trials 5 ($\chi^2 = 6.29$), 8 ($\chi^2 = 6.29$), and 10 ($\chi^2 = 4.16$) was significantly different from chance accuracy (10% correct) at the .05 level. This result showed that visual cueing was not necessary for some senders to indicate correct responses to receivers; touch was sufficient.

In *ribbon-contact trials*, the percentage of total CR did not exceed co-incident probability except in Trial 3, $\chi^2(1) = 3.95$, $p < .05$. The mean

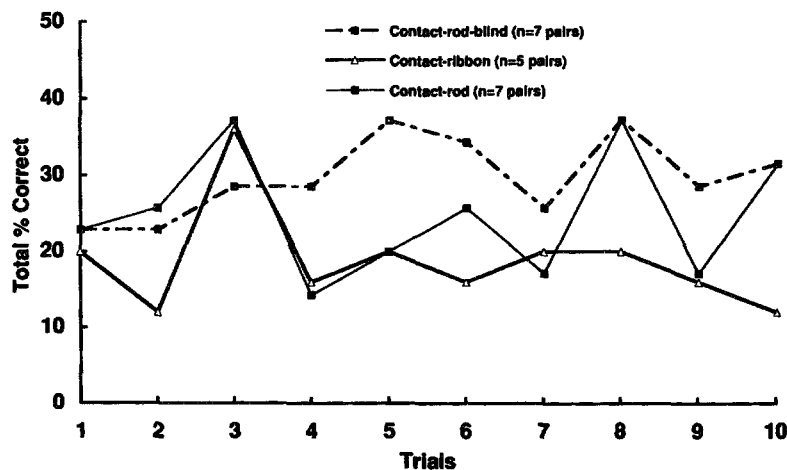


Fig. 8. Total percentage of correct responses on contact rod-blind and contact ribbon conditions.

percentage correct for all trials was 18.8%. This included one pair in which the receiver reported to have used visual cues consciously. When the receiver of this pair was blindfolded (while maintaining ribbon contact), the total CR decreased dramatically (from 20/50 to 5/50). The mean percentage of CR for all trials, excluding the trials for this pair, dropped to 13.5%. Similarly, the significant difference for the Trial 3 was eliminated. These results indicated that application of pressure was necessary for senders to convey intended responses.

EXPERIMENT 5

Conditions were established to test the motor control hypothesis and to determine which hypothesis is best supported, the pressure-cue hypothesis, or the motor control hypothesis. Pressure applied from the outside causes changes in receiver's tactile sensations, but does not necessarily change his/her movements. To exercise control, however, it is necessary for the sender to apply a force from the outside to bring about a change in the receiver's movements. Furthermore, the control must be applied accurately so that the movement can be directed towards the target. The motor control hypothesis suggests that the receiver will not perform correctly when the sender is unable to accurately intervene in the movements of the receiver.

To test this, the following three points were examined: (a) Even if pressure was applied to the receiver, the receiver would fail if the sender was unable to intervene in the receiver's movements. (b) For the sender accurately to control the movements of the receiver, there was a need for receiver-movement feedback. If this feedback were blocked, control would become inaccurate and the receiver would fail. (c) If the force operating on the receiver from the sender were blocked by a buffer, control would become inaccurate and answers would be incorrect.

Method

To test these predictions, the following three conditions were established, in the telepathy game context:

Contact Rod-Nonmoving. Contact between the receiver and sender was achieved via a rod. Both placed their hands on the cart and did not move them above the keyboard. The numbers 1 through 10 were sequentially displayed on the screen of the VTR to the side of the apparatus. The sender and the receiver watched the screen together. When the number

the receiver guessed was correct appeared on the screen, the receiver pressed a key that was close at his/her hand. There was a rod between the two persons, so if one of them moved even a little, the sense of pressure was changed and transferred. The movements of the receiver, however, were limited to the up and down movements of the finger when pressing the key. Intervention in these movements by the sender through a rod could not be achieved in this structure because the finger moved independently while the rod and hands remained lightly fixed on the carts.

Contact Rod-Blind (Senders). Contact between the receiver and sender was achieved via a rod. The sender was blindfolded to block visual feedback from the receiver. The numbers on the keyboard were arranged randomly to eliminate the possibility of the sender remembering the general position of the keys and inferring the number from the position of his/her hand.

Contact Spring. Contact between the receiver and sender was achieved via a spring. Rings were attached to both sides of a spring (14 cm). These were worn on the fingers on hands of the sender and receiver which were placed on their respective carts. Force from an imbalance in the movements of the two persons was buffered by the spring.

Five of the SRI pairs from the Experiments 3 and 4, friends ($n = 3$), sisters ($n = 1$), colleagues ($n = 1$), also participated in this experiment.

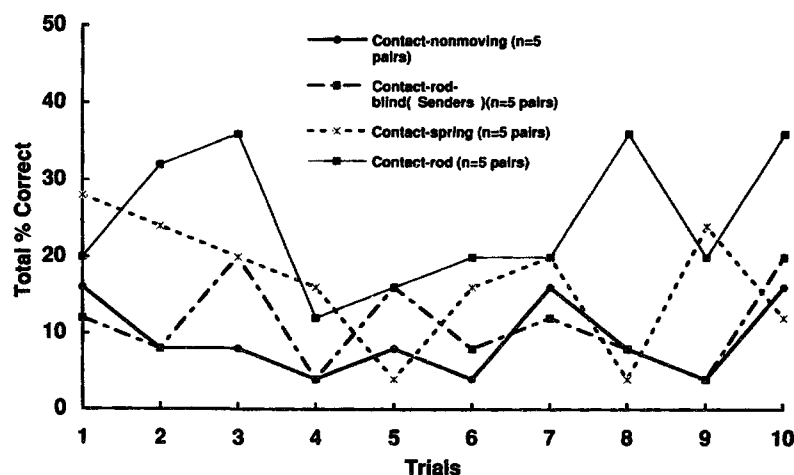


Fig. 9. Total percentage of correct responses on contact-nonmoving, contact rod blind (senders) and contact-spring conditions.

Results and Discussion

In each condition, the percentage of the total CR was not significantly different from the level of chance (chance = 10% correct) (Figure 9). The mean percentage of correct responses for all trials was 9.2% for contact rod-nonmoving trials, 11.2% for the contact rod-blind trials, and 16.8% for the contact-spring trials. (The previous contact-rod performances by these subjects are shown in Figure 9 for comparison.)

This showed that for the sender to control the receiver's responses, a force that changed the speed of the receiver's movements was necessary, and pressure that did not change it was not sufficient. When we try to move a stationary person by applying force, we need a great force, but it was supposed that when we are moving together, it is possible easily to change the speed and direction of the partner's movements with minimal force. The results of the experiments conducted under these three conditions support the motor control hypothesis.

Detecting a Change in Force

If the sender exercises control by applying a force, that force should appear as a strain in the rod. To confirm this point, I examined each reaction of the contact rod trials (C) and contact rod-blind trials (B) in subjects for the key position at which the rod strain changed significantly during the trial.

In the contact-rod trials (C), a total of 826 trials for 23 pairs were analyzed. This accounted for 9 pairs of SR (successful receivers) (C), and 14 pairs of FR (failed receivers) (C), excluding inadequate records from the SRI and FR groups in Experiment 3. In contact rod-blind trials (B), a total of 14 subject pairs (included the participants in Experiment 4) and 557 trials were analyzed. According to the average of the CR totals, the pairs were divided into 7 upper group pairs: SR(B) and 7 lower group pairs: FR(B). The error responses resulting from the receiver striking a key before reaching the correct key were seen as inappropriate data for determining the relationship between correct response position and strain, and were therefore discarded.

The strain curve was differentiated and that value was made an index of the force gradient. The method for calculating the strain-differential value is the same as in Figure 3, but for average and standard deviation, the keyboard end values (the positions of Keys 10 and 1) were excluded in cases where the correct answer was other than 10 or 1. This was because the direction of movement changed at the ends of the rails, resulting in a

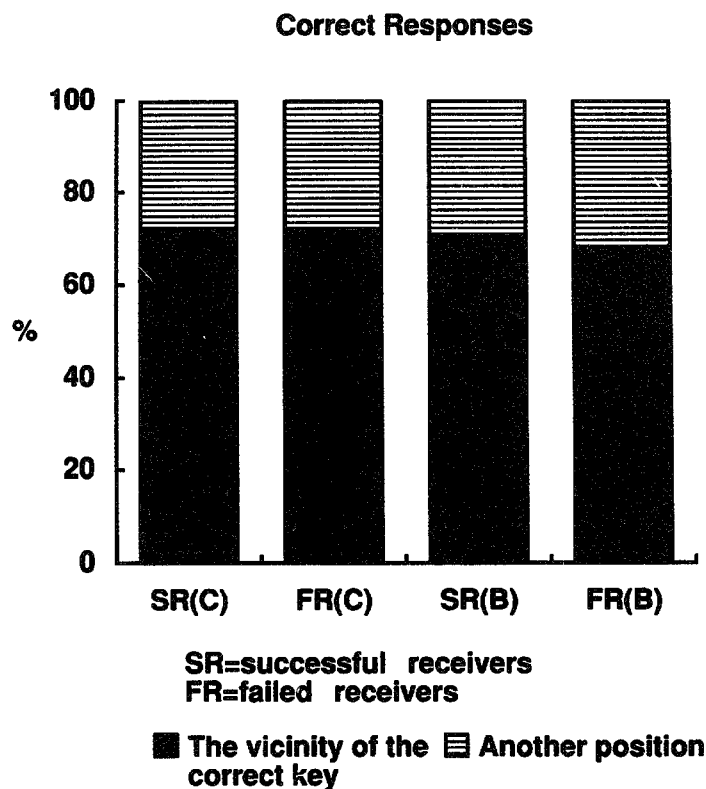


Fig. 10. Comparison of force change in correct responses of successful receivers and failed receivers.

deviation in the two individuals' movements and a tendency for strain to become larger.

For each trial, the key position in which significant change occurred most frequently was obtained and categorized as either in the vicinity of the correct key (correct key or next key) or another position. Figures 10 and 11 show the proportion between these two categories for each group.

The results can be summarized as follow: (a) There tended to be a change in force for all groups, either in the vicinity of the correct key (in the case of correct responses, CR and CCR) or in positions other than correct positions (in the case of errors). (b) Group differences in errors emerged. There were slightly more cases in which FR group had frequent changes in the vicinity of the correct key, even when the eventual response

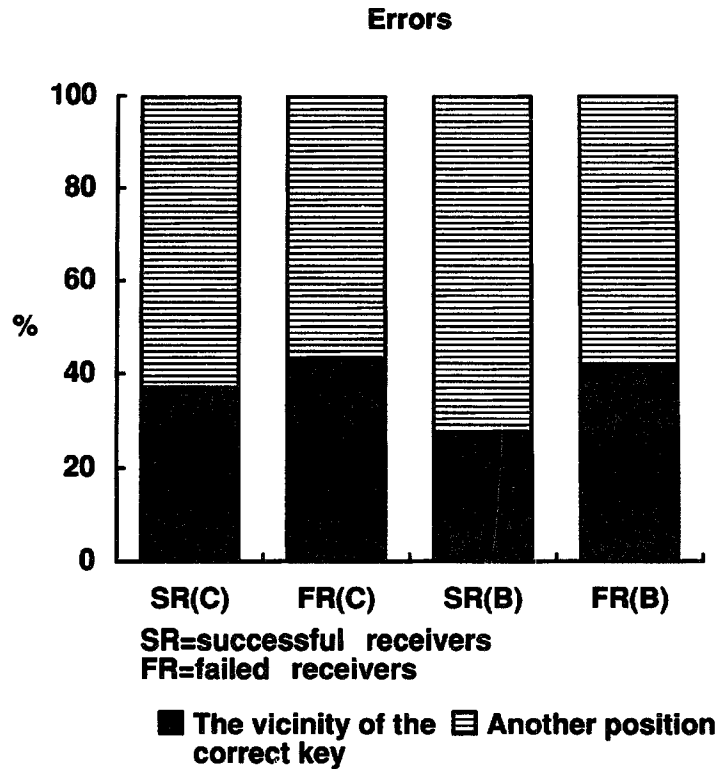


Fig. 11. Comparison of force change in errors of successful receivers and failed receivers.

was incorrect. In contact rod-blind trials (B), the difference between the groups was significant, $\chi^2(1) = 4.961$, $p < .05$.

These results showed that in the vicinity of the correct key, the movements of the two persons were not synchronized and that a force was exercised on the partner leading him/her to the correct answer. This suggests that the failed receiver was either unaware of, or ignored, the change in force in the vicinity of the correct key and struck another key; and that the successful receiver, by contrast, grasped the changes in force near the vicinity of the correct key and rarely missed the correct answer. Some of the receivers reported that their hands felt heavy when they moved past the correct answer, indicating a direction in which the sender did not want to go. The senders unintentionally applied a force that would naturally move the receiver's hand in that direction. It was inferred that skilled re-

ceivers and unskilled receivers could be distinguished by whether they could effectively use a strategy to ascertain the direction in which the force was being applied.

GENERAL DISCUSSION

What happened to the senders during these experiments was a type of ideomotor phenomenon (Richter, 1957). This was discovered to be involuntary movement in research on table-turning conducted more than a century ago (Faraday, 1853). This type of unconscious muscular movement of the senders occurred constantly. Numerous visual cues were also reported by the receivers, including movement of the sender's fingers above the cart, wavering of the head, and stopping of the eyes in the vicinity of the correct answer. The SR11 group in Experiment 3 must have used these cues (see Figures 5 and 7). This resolution of problems through visual cues is well-known as the "Clever Hans effect" (Sebeok & Rosenthal, 1981).

The phenomenon of control of spelling responses in FC, however, is different from a common Clever Hans effect. The distinguishing feature is that the ideomotor activity works as a force that changes the speed and direction of the partner's movements through synchronized movements before the key is struck. This is inferred to be easier to sense than the partner's muscle movements detected visually. In FC, pulling back the subject's hand after he/she has struck the key is recommended (Biklen, 1990, 1992, 1993; Biklen et al., 1992). This is control on the overt level. This type of control probably shifts gradually to control on the covert level without the facilitator being aware.

The process whereby the subject moves and receives feedback from the facilitator likely involves operant conditioning. In J's case, the assistant's satisfaction or praise following responses was a possible positive reinforcer for J. J experienced this type of learning for more than 6 years, so she naturally became skilled. Her search process was virtually instantaneous. When a new method of physical support was introduced, she resisted. When the assistant set her hand on J's head, the upper half of J's body would become stiff. When the assistant put her hand on J's back, J would put weight against the hand. J would adjust the position of her body, like a sensor, to find the easiest way to receive the force depending on the location touched by the assistant. The pressing of keys was smoothest with assistants with whom she was familiar and it sometimes became impossible with assistants with whom she did not associate for some time. The assistant and J seemed to move as unity in symbiosis; it was not a simple relationship of one partner acting on the other.

In this study, I have demonstrated the mechanisms by which an autistic person appears to be able to communicate through FC. The role of contact is not one of emotional support or even simply physical support, but one of motor control. FC advocates claim that the facilitator can detect the intentions of the subject's movements, and support and control the movements to realize those intentions. This study, however, shows that the facilitator restrains the movements made by the subject in directions away from correct key positions. As a result, movements in line with the intentions of the facilitator are executed. In principle, one small point of physical contact is sufficient for the transfer of force from the facilitator. Even brief contact, such as a loose ribbon momentarily pulled taut, is sufficient. For an experienced subject and facilitator, it is sufficient for the facilitator to control the subject's responses merely by sitting next to him or her (Biklen et al., 1992). Even a single pencil pressed against the back makes this possible (Crossley & Remington-Gurney, 1992). Furthermore, it is entirely possible for facilitators to control their partners' responses without direct physical contact using subtle visual or auditory signals (cf. Sebeok & Rosenthal, 1981).

In conclusion, this study proves that it is untenable to claim that a subject has a high level of intelligence or literacy just because very abstract concepts or sophisticated statements seem to be produced when someone uses FC with the subject (Biklen, 1990, 1992, 1993; Biklen et al., 1992; Crossley, 1992; Crossley & Remington-Gurney, 1992). There are simpler more plausible explanations.

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