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# AN EXPERIMENTAL STUDY OF "FEINT": RELATIVE EFFECTIVENESS OF DISTANCE AND DURATION OF FEINT[1]

By

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A "feint" is a technique used in many sports. In this experimental study, we investigated the effectiveness of the duration and the distance of feint movement on the induction of the head movement. Subjects were asked to turn his head in the direction (right or left) opposite to the direction pointed by the experimenter. A feint was a quick and small movement of the finger in the direction opposite to that of the ultimate pointing and it was given precedent to the pointing. In a half of trials the experimenter's pointing movement accompanied feint movement and in the other half did not. A discriminant analysis revealed that only the distance of feint movement was a significant contributing factor to the discrimination between the correct and error reactions. A mechanism underlying the decision process in the "feint" situation was discussed.

**Key words**: feint, pointing, head movement, motor control

## INTRODUCTION

The technique called a "feint" is used widely in many sports such as basketball, soccer, and fencing. In feinting, (1) the player moves slightly in the direction which differs from that of his aim. (2) He makes his opponent to have the anticipation that he will move in that direction. And (3) he moves in the direction which is different from the direction anticipated by his opponent.

Ohtsuki and his colleagues made the experimental studies of the correction of error reaction caused by feinting stimulus (Ohtsuki and Ishiwari, 1978; Kawabe and Ohtsuki, 1982; Ohtsuki and Kawabe, 1983). In their experiments, the subject was asked to extend and flex his wrist repeatedly in accordance with regularly alternating

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light stimuli (right–left) to establish the anticipation to stimulus presentation. In the course of stimulus presentation one light was turned on twice consecutively, e.g., as right -left-right-*right*-left, to belie the subject's anticipation. The second of the two consecutive stimuli caused the error reaction. They obtained the minimum time necessary for changing an ongoing error movement into a new correct movement. The results were that the switching time was divided into two phases : the duration of error EMG (P1), which increased from 50 to 250 msec in proportion to the intensity of error reaction, and the silent period with no electrical activity from the disappearance of error EMG to the appearance of correct EMG (P2), which ranged between 40 and 60 msec irrespective of the intensity of error reaction. They discussed that the switching of movement consists of two processes : (1) canceling of the ongoing motor programs, which is related to P1, and (2) issuing new motor commands, and that these two processes of switching do not occur independently of each other but with some temporal relation.

In their experiment, the temporal aspect of feint was examined. However, in practical situations, feint motion involves spatial aspect as well as temporal aspect. The present experiment was designed to clarify the relative effectiveness of two factors.

In the experiment reported here, the experimenter pointed to the right or to the left with his index finger in front of the subject's face. The subject was required to turn his head quickly opposite to the pointing (see Figure 1.A). In a half of trials, the experimenter's pointing movement accompanied feint movement, which was a quick and small movement of the finger in the direction opposite to the ultimate pointing, and which was given precedent to the pointing (see Figure 1.B).

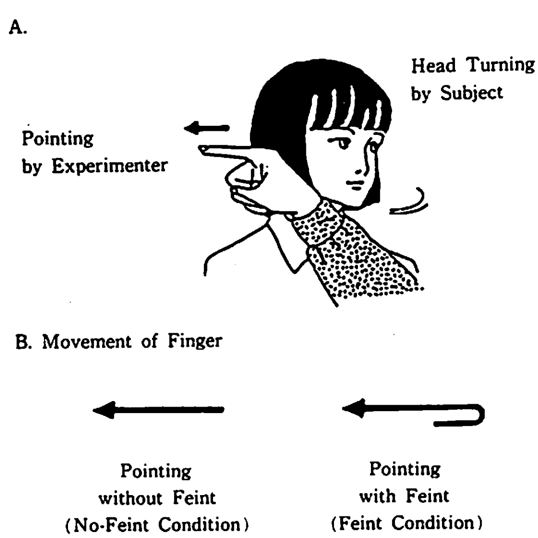


Fig. 1. Illustration of the procedure used in this experiment (A) and movement of finger in no-feint and feint conditions (B).

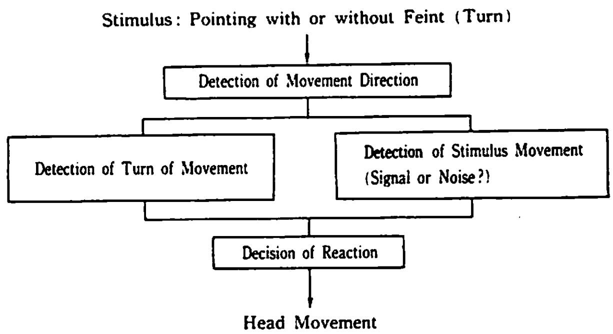


Fig. 2. The model for the procedure used in this experiment.

Here, we would like to propose a model, on which we rely to interpret the results of the procedure mentioned above. Figure 2 shows the model schematically. This model involves four independent sets of processes. The four sets include (1) the detection of movement direction, (2) the detection of stimulus movement (signal or noise ?), (3) the detection of turn of movement, and (4) the decision of reaction. In the first process, the direction of finger movement, to the right or to the left, is detected. In the detection process of stimulus movement, the detection is made on whether the finger movement is the pointing to which the reaction is to be done (signal) or not (noise). And a certain extent, in time or in distance, of movement is necessary for this detection. When the stimulus contains a feint before the ultimate pointing, the finger makes a turn in the half way of its movement. In the detection process of turn of movement, the turn of movement of finger is detected. And in the decision process, the reaction is selected and executed, according to the consequence of these three processes.

In the case where the stimulus does not involve feint movement (see the upper part of Figure 3), when the movement of finger exceeds a certain extent, the detection is done that the movement of finger is the pointing to be responded (signal). Then the decision of reaction is made. In this case, the head turning opposite to the ultimate pointing is selected as reaction, which results in a correct reaction. On the other hand, when the feint proceeds the pointing, two cases are possible depending on the spatiotemporal characteristics of the feint movement. First, when the feint movement exceeds a certain extent which is necessary for the detection of stimulus movement (see the middle part of Figure 3), the detection of stimulus movement is made earlier than the detection of turn of movement, and the decision process works according to the consequence of the detection process of stimulus movement. In this case, the feint movement is detected as stimulus to be responded (signal), and the head turning is selected as reaction in the direction opposite to that of the feint movement, that is, in the same direction as that of the ultimate pointing. This yields an error reaction. Secondly, when the extent of feint movement does not exceed that necessary for the detection of the stimulus movement (see the lower part of Figure 3), the turn of

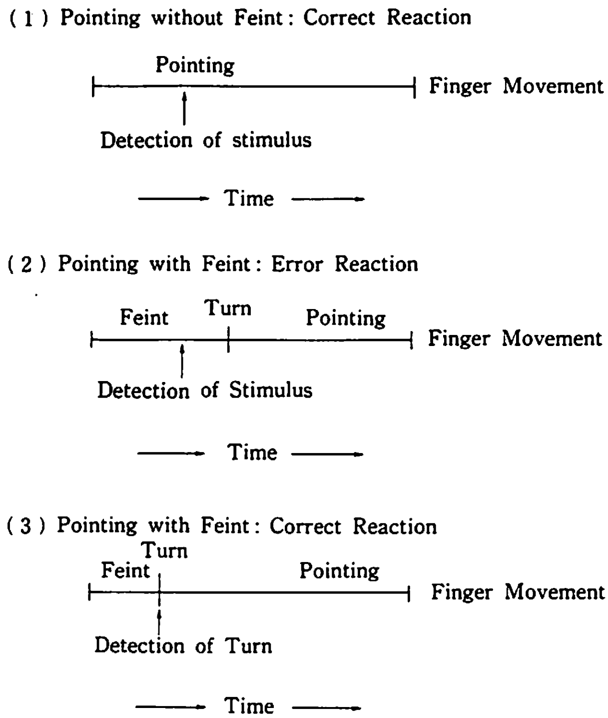


Fig. 3. Three cases predicted from the model.

movement is detected before the detection of stimulus movement occurs, and the decision process works according to the consequence of the detection process of turn of movement.

In this model, a certain "extent" of movement is necessary for the detection of stimulus movement. Does the "extent" mean the duration or the distance of movement or both ? It is the main question to be examined in this paper.

If the detection of stimulus movement depends on the duration of movement (duration hypothesis), the difference between the feint movement which causes correct reactions and the feint movement which causes error reactions will appear only in their duration. However, if the detection of stimulus movement depends on the distance of movement (distance hypothesis), the difference between the feint movement which causes correct reactions and the feint movement which causes error reactions will appear only in their distance.

If the duration hypothesis is correct, there will not be difference in RTs between correct reaction for no-feint condition and error reaction for feint condition, because in both of them the equal amount of time is required for the judgment of stimulus movement. In feint condition, the finger has to stop in the halfway of its movement to make a turn, so the velocity of the earlier part of its movement is supposed to be smaller than that in no-feint condition. Therefore, if the distance hypothesis is correct, RTs of error reaction for feint condition will be greater than those of correct reaction for no-feint condition.

## METHOD

*Procedure* : In order to examine the effectiveness of feint, the "Acchi Muite, Hoi" (Look at, hoy) procedure, which was adopted from Japanese children's game, was used in this experiment. As shown in Figure 1.A, in this procedure, after moving his index finger up and down twice in front of the subject's face with a call signal ("Acchi Muite" in Japanese), the experimenter pointed to the right or to the left with a call signal ("Hoi !" in Japanese). The subject was asked to turn his head opposite to the pointing as quick and accurate as possible. Two hundred trials were presented in ten blocks for each subject. In a half of trials, feint movement proceeded the ultimate pointing (feint condition). In the other half, the pointing without feint was given (no-feint condition). The feint was a quick and small movement opposite to the ultimate pointing (see Figure 1.B). The experimenter gave the feint movement so that the duration and the distance of it might vary to some extent. Each condition consisted of 100 trials, divided equally into right and left pointing trials. The order of conditions within blocks was randomized. Viewing distance was about 50 cm. The movement of the experimenter's finger as stimulus and that of the subject's head as reaction were recorded respectively with two video cameras with zoom lenses (SONY, AVC-3360S). The two pictures were combined by a video camera wiper (SONY, CMW-100A) into one split-screen view.

*Subjects* : Three graduates and nine undergraduates (seven males and five females) of Tohoku University participated in the experiment as subjects.

## RESULTS AND DISCUSSION

*Analysis of Data* : Data of four subjects were excluded from the analysis : (1) a subject, who decided his reaction by the use of the experimenter's eye movement as a clue, (2) two subjects, whose correct reaction rate was below 75% for no-feint condition, and (3) a subject, whose pictures of the video recording were not clear. Also, when the pictures of the video recording were not clear on each trial, the data of that trial were excluded.

Movement of the experimenter's index finger and the subject's head recorded in video tapes were analysed by the method of microanalysis (Murai & Nihei, 1983). A microcomputer (NEC, PC-9801) was connected to a CRT via an electronic device, so that the outputs from both VTR and computer were mixed onto one CRT screen. The X-Y coordinates of any points on a stopped video tape image could be detected by means of the computer, which also stored the data in a floppy disk medium.

In the present study, the X coordinate values as a function of time (every 33 msec)

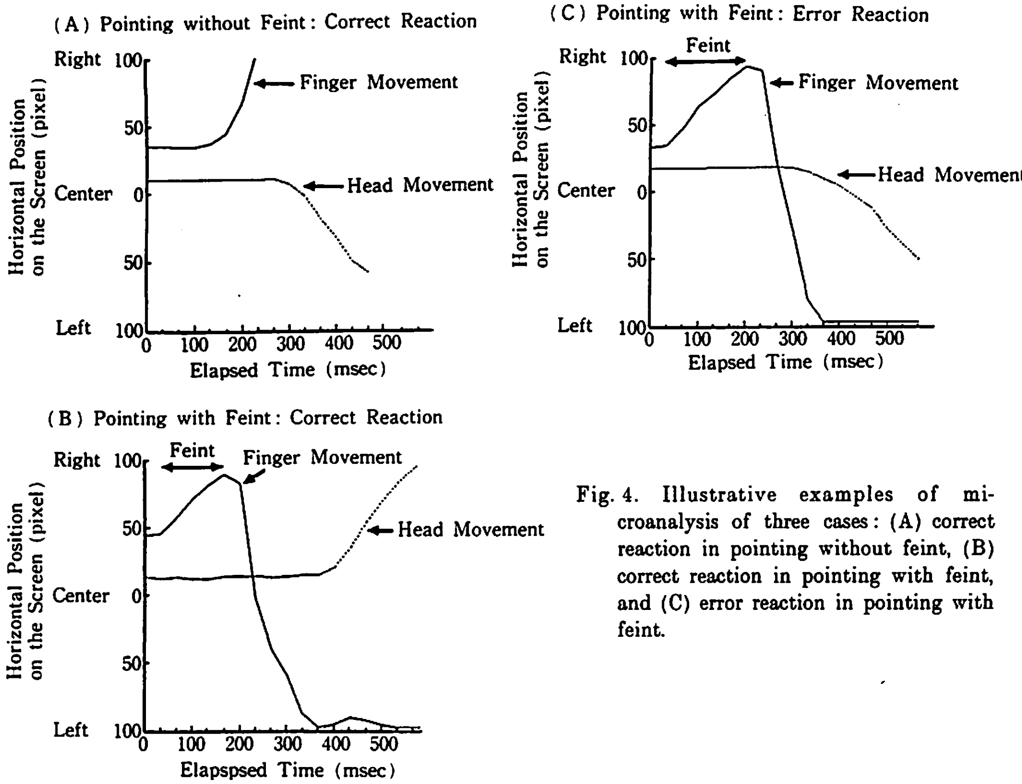


Fig. 4. Illustrative examples of microanalysis of three cases: (A) correct reaction in pointing without feint, (B) correct reaction in pointing with feint, and (C) error reaction in pointing with feint.

were plotted by employing computer, thereby enabling us to microanalyze the relation of subject's lateral head movements to the laterally moving experimenter's finger (see Figure 4).

The starting point of movement in the stimulus and in the reaction were determined when the index finger or the eye shifted over two pixels in the right or left direction consecutively without up and down movement.[4] In the video recording, the frame rate was 30 frame/sec and a pixel represented the distance of about 0.74 mm. When the subject's head turned in the same direction as that of the ultimate pointing, the reaction was regarded as an error. When the head turned in the direction opposite to that of the ultimate pointing, the reaction was regarded as correct. When the head turned at a slightest distance in the same direction as that of pointing at first and then turned finally opposite to that of pointing, the reaction was regarded as an error.

The pattern of results was consistent with subjects. The mean numbers and rates of the correct and error reaction were shown in Table 1. A three-way analysis of

4. The experimenter intended to equalize the number of trials between feint and no-feint conditions. However, as his actual finger movements were classified into the pointing with feint and the pointing without feint upon this criterion, the number of stimuli in feint condition was not equal to that of stimuli in no-feint condition

Table 1. Mean number (percentage) of each reaction for each condition.

| Pointing | Condition | No-Feint | | Feint | |
|---|---|---|---|---|---|
| | Direction | Right | Left | Right | Left |
| Reaction | Correct | 51.6 (88.1) | 30.6 (83.6) | 23.3 (57.2) | 39.8 (62.1) |
| | Error | 7.0 (11.9) | 6.0 (16.4) | 17.4 (42.8) | 24.3 (37.9) |

variance (Feint (with/without) × Direction (right/left) × Subjects), performed on the arcsine square root transforms of the data of the correct reaction rate, revealed that the correct reaction rate was significantly higher for no-feint condition than for feint condition: $F(1, 7) = 60.97$, $p < 0.01$. However, neither the effect of direction of pointing nor the Feint × Direction interaction proved to be significant: $F(1, 7) < 1$ and $F(1, 7) = 3.53$, respectively.

Almost all the subjects showed a similar tendency as to the duration and the distance of feint movement which caused the correct and the error reaction. Both the mean duration and the mean distance of feint movement which caused the error reaction (127 msec and 1.9° in visual angle, respectively) were greater than those of feint movement which caused the correct reaction (111 msec and 1.5° in visual angle, respectively). To examine the effects of the duration and the distance of feint movement more closely, a discriminant analysis was carried out on the data of individual subject. The distance of feint movement was found to be a significant contributing factor, in three subjects of eight, to the discrimination between the correct and error reactions: $F(1, 126) = 14.65$, $p < 0.01$; $F(1, 102) = 6.81$, $p < 0.05$; $F(1.80) = 5.26$, $p < 0.05$; $F(1, 102) = 2.95$, $p > 0.05$; $F(1, 110) = 2.05$, $p > 0.1$; $F(1, 87) = 1.64$, $p > 0.2$; and $F < 1$ for two subjects. But the contribution of duration was not significant in any subjects: $F(1, 87) = 2.54$, $p > 0.1$; $F(1, 126) = 1.66$, $p > 0.1$; and $F < 1$ for six subjects. The probability of misclassification ranged from 0.35 to 0.47. These results showed that the distance of feint movement might be an effective factor and the duration was not. However, the relatively low discriminability (0.65–0.53), when two variables were used as discriminating variables, suggests factors of distance and duration are not sufficient to discriminate between the correct and error reactions.

Figure 5 shows mean RTs of each reaction for each condition. As a few number of error reactions for no-feint condition were obtained, they were eliminated from the following analysis. The mean RTs of correct reaction were 182 and 266 msec for no-feint condition and feint condition, respectively. The mean RT of error reaction was 245 msec for feint condition. An unweighted means two-way analysis of variance (Conditions × Subjects) yields the significant difference of conditions: $F(2, 14) = 106.10$, $p < 0.01$. Tukey paired comparisons between conditions' mean RTs showed that RTs of correct reaction for feint condition were significantly greater than those of error reaction for feint condition ($p < 0.01$) and both were significantly greater than those of correct reaction for no-feint condition ($p < 0.01$). In the part of introduction,

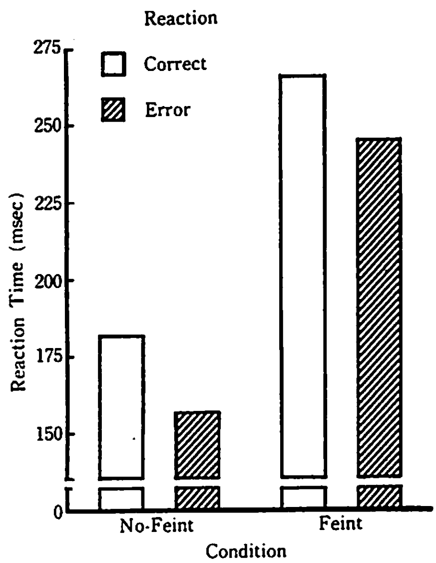


Fig. 5. Mean reaction time of each reaction for each condition.

two hypotheses (duration and distance) predict the different results concerning the difference in RTs between correct reaction for no-feint condition and error reaction for feint condition. This result and the resuts of discriminant analysis mentioned above, therefore, support the distance hypothesis that the detection of stimulus movement depends on the distance of movement.

Ohtsuki and his colleagues found that only EMG appeared but the feinted movement did not occur in some trials. It indicates that the ongoing motor programs can be canceled before the execution of overt response (Ohtsuki and Ishiwari, 1978 ; Kawabe and Ohtsuki, 1982 ; Ohtsuki and Kawabe, 1983). And in the race model for the countermanding procedure, Osman et al. (1986) assumed that the overt response which would be produced by the controlled process can be inhibited by the inhibition process which followed the controlled process. In some trials of the present experiment, the switching of response was observed. That is, the subject began to turn his head in the same direction as that of stimulus movement, but immediately turned his head in opposite direction to respond correctly. It is supposed that in the switching of response, the first movement was inhibited in the halfway and the other movement was substituted for the first. Also, in the correct reaction for feint condition, it is possible that the response to the feint movement is prepared first, but it is inhibited, and then the other response to the ultimate pointing is prepared and executed. It might be necessary to introduce the canceling or inhibition process into our model.

The procedure used in the present study is considered to reflect well the actual "feint" situation. But the control of stimulus movement was not sufficient, because the finger movement was used as stimulus. In further research, it will be necessary to reexamine the above results and the model, using feinting stimuli which can be varied more systimatecally.


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