ABSTRACT
The purpose of this study was to provide evidence that the low manual dexterity among people with mentally retarded came from the interference between an input of visual information and an output of motor control.

Previous studies had shown that gazing behavior during a reaching task got delayed about 200ms among mentally retarded people who engaged in practical work situations. The analysis of scan paths obtained from such work situations had indicated that persons with mentally retarded tended to gaze the target object repeatedly when their hands were about to reach to it, and then they monitor and engage in feedback control of their hand. It was hypothesized that the cause of this delay stemmed from the difficulty of getting visual information about the target object. To test this hypothesis, the present study compared the performance of a tracing task between normal and mentally retarded participants, with applying a forced visual delayed feedback to only the normal participants. Several conditions were set to manipulate the levels of the delay, and tracing errors were measured. The analysis revealed that the normal participants had shown a similar performance to mentally retarded participants when they had received 200ms of visual delayed feedback. The result of this study was relevant to the previous literature, and also providing new evidence that the low manual dexterity of persons with mentally retarded had largely stemmed from the difficulties of getting visual information in regard to reaching action. The implications of assisting and improving low dexterity among people with mentally retarded were discussed.

INTRODUCTION
Persons with mental retardation (PMR) showed low dexterity (e.g. Bruninks, 1971). Why do they show less manual dexterity? Weiss & Kivlager (2003) showed that the performance related to visuo-motor coordination of PMR was worse than those without mental retardation. Oka & Murai (2008) showed that the less performance in dual-task was due to interference in perception and reaction planning, not by a problem in allocation of attention.

We showed that a gaze to a target of PMR lag behind reaching to the target (Oka & Murai, 2007). The traces were approximately 200 ms. The result indicated the PMR did not use feedforward (FF) control. Shumway-Cook & Woollacott (2001) pointed out that the longer the delay time, the less amplitude and the more phase.

We investigated:
- Whether PMR used two types of control system well or not.
- Whether we can replicate the less dexterity observed among PMR by being restricted FF control or FB control of persons without MR.

METHOD
Participants
<table>
<thead>
<tr>
<th>With mental retardation (PMR)</th>
<th>Without mental retardation (control)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>2 (Participants A &amp; B)</td>
</tr>
<tr>
<td>Age</td>
<td>Av. 22.62±20.46 (46)</td>
</tr>
<tr>
<td>IQ (WISC-R)</td>
<td>Av. 35.26±23.24, 26.24 (46)</td>
</tr>
<tr>
<td>VQ</td>
<td>Av. 46.86±46.46, 46 (46)</td>
</tr>
<tr>
<td>Vision</td>
<td>all normal</td>
</tr>
</tbody>
</table>

Tasks and Design
- Tasking with Digital Pen
  - Ave. Max. Co. / dia. 10mm / 2 trials / 30g / resolution capability: 0.3mm / sampling rate: 13ms
  - #Two types of sine curve line: 220mm
  - #Easy action planning
  - #Hard action planning
  - #Two experimental conditions and one control condition.

RESULT
- No restriction condition (control)
  - Interpretive model
    - Control
      - Only the phase became lower
    - PMR
      - "Run away"
  - Typical example
    - Control
      - The smaller the pre-visible area, the lower accuracy but the phase did not change.
    - PMR
      - The larger the pre-visible area, the less accuracy but the phase changed.
  - Speed-up with loss of accuracy
    - Control
      - Decreased speed, the accuracy became lower.
    - PMR
      - speed did not change, the accuracy became lower.

CONCLUSIONS
The features of PMR performance were...
1. Comparing the base line, the amplitude became lower, but the phase was still same level.
   - This is well accorded with the result of the FF restricted condition on participants without mental retardation.
   - This result indicates that PMR with deficient acquisition of pre visual information use FF control system mainly, which induces the poor performance. And then, they try to modify the motor control.

2. Comparing the complex line condition, the trace accuracy became lower, but the tracing speed was still same.
   - This is well accorded with the result of the FB restricted condition on participants without mental retardation.
   - This result indicates that the modification of the motor control provide a interference between on going motor programming and modified motor programming. And that should be the reason of the loss of visuo-motor performance of PMR.