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**Research Article,**

# Evaluation of Simple Screening for Attention Functions

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## Abstract:
We hypothesized that a combination of multiple tasks consisting of suppression of blinking and sustaining maximum muscle force in pinching serves as a simple screening test for declines in attention functions and investigated the relationships of suppression of blinking, the number of blinks during measurement of pinch strength, and attention functions. The subjects were 27 young individuals (10 males and 17 females with a mean age of 31.9±13.8 years) and 12 elderly individuals (2 males and 10 females with a mean age of 73.3±5.6 years). Part A and Part B of a Japanese version of the Trail Making Test (TMT) were used to evaluate attention functions. The subjects were instructed before the measurement of pinch strength to stop blinking for 5 seconds, and the number of blinks was counted. Pinch strength was measured for 5 seconds, and its changes were recorded. No instructions were given in the first measurement of pinch strength, but the second measurement was performed after the instruction of "Do not blink" (with restriction of blinking). TMT-Part A with restriction of blinking took more time in the group that blinked than in the group that did not blink (41.1±16.4 vs. 25.6±8.7, $p<0.01$). The subjects who required more time to execute TMT-Part A tended to be more likely to blink even under restriction. Examination of the presence or absence of blinking under restriction before the measurement of pinch strength is considered to be potentially useful as a simple screening test for attention functions.

**Key word:** attention, blinking, pinch strength,

## Introduction:
In mild cognitive impairment (MCI), impairment of cognitive functions, such as attention and execution functions, is observed [1]. A study in which tasks, including calculation during walking, were given to frail elderly people reported slowing of the gait speed associated with declines in attention functions [2]. Tests involving walking may accompany the risk of the subjects' falling. The Trail Making Test is a test of attention functions used for the assessment of cognitive function in rehabilitation [3 4]. This simple pencil-and-paper test can comprehensively measure attention, working memory, spatial exploration, and processing speed. However, its application is limited to an environment in which the subjects can concentrate for about 5 minutes and individuals who are capable of writing. Cognitive function is associated with finger dexterity [5 6], which is also related to finger muscle strength (pinch strength) and sensibility [7].

In addition, examination of blinking can be distinguished as intentional or reflexive and reflects cognitive function and the attitude to information processing [8]. Blinking can be controlled intentionally by individuals to an extent [9]. We, therefore, considered that a combination of the multiple tasks of sustaining maximum strength of pinching and suppression of blinking may serve as a simple screening method for attention functions that can be newly applied to the fields including rehabilitation. We carried out this study by hypothesizing that pinch strength and the number of blinks under restriction of blinking are related to attention functions.

## Materials:
The subjects were 27 young individuals (10 males and 17 females with a mean age of 31.9±13.8

years) and 12 elderly individuals living independently (2 males and 10 females with a mean age of 73.3±5.6 years) in Hiroshima Prefecture. Those with mental disorders, including dementia or physical symptoms that might interfere with testing, were excluded.

All subjects were given an explanation about the objective of the study and measurements and consented in writing. This study, anonymized for the protection of personal information, was carried out with approval by the ethics committee of Hiroshima Cosmopolitan University (2019004).

## Methods:

The measurements were performed from July to December 2021 with precautions for the prevention of COVID-19 infection. The subjects' attention functions were evaluated using a Japanese version of the Trail Making Test (TMT), and the subjects underwent TMT-Part A (Part A) and TMT-Part B (Part B) [10]. Before the test, the subjects were instructed to hold a pencil with their dominant hand, and the time needed for the test was measured with a digital stopwatch.

Pinch strength was measured by seating the subject in a chair with both knees bent at right angles and the soles of both feet on the floor and with both elbows bent at right angles [11]. The subjects were instructed to pinch the pinch gauge placed on the desk with maximum force using the thumb, index finger, and middle finger of the dominant hand[12 13].

Pinch strength was measured using an attachment for pinch strength (T.K.K.1269m Takei Scientific Instruments Co., Ltd.). The results obtained were output digitally (v) using a strain amplifier (T.K.K.1268 Takei Scientific Instruments Co., Ltd.) and an A/D converter (T.K.K.5721 Takei Scientific Instruments Co., Ltd.). Pinch strength was measured twice over a maximum of 5 seconds each time using a digital stopwatch [14]. The interval between the first and second measurements was 60 seconds [15]. No instruction was given (without restriction) in the first measurement, but the instruction, "Do not blink", was given (with restriction) in the second measurement. In the 5-second pinch strength measurement, the means of the values obtained in 1/100 second fractions over 1 second were calculated in addition to the maximum strength.

Blinking and pinch strength were examined by an observer seated in a chair. The number of blinks was counted using a digital camera (SAMSUNG).

The subjects were divided into those aged <65 years (young group) and those aged ≥65 years (elderly group). To evaluate the relationship between blinking and cognitive function, they were also divided into those who blinked during the measurement of pinch strength with restriction of blinking (blink group) and those who did not (no blink group).

The data were analyzed using commercial software (SPSS ver. 26, IBM). Mean values of the continuous variables were calculated, and the data were presented as the mean ± standard deviation (SD) in the tables and as the mean ± standard error (SE) in the figures. A p value of <0.05 was regarded as statistically significant.

## Results:

The data obtained by the measurements are shown in Tables 1 and 2.

**Table 1. The difference of social background, pinch strength and TMT with young and elderly.**

| | ALL | young | elderly | p value |
|---|---|---|---|---|
| n | 39 | 27 | 12 | |
| Age | 45.8 ± 24.2 | 31.9 ± 13.8 | 74.4 ± 5.6 | <0.01 |
| Sex(man), n(%) | 12 (30.8) | 10 (37.0) | 2 (16.7) | 0.09 |
| The number of blinks during the 5 seconds at rest, n | 0.6 ± 1.0 | 0 | 0.3 ± 0.5 | 0.08 |
| The number of blinks during the measurement of pinch strength, n | 0.9 ± 1.4 | 0.6 ± 1.2 | 1.5 ± 1.7 | 0.13 |
| The number of blinks during the measurement of pinch strength without blink, n | 0.4 ± 0.7 | 0.4 ± 0.7 | 0.6 ± 0.7 | 0.37 |
| Pinch strength, N | 8.0 ± 2.4 | 8.8 ± 2.3 | 6.1 ± 1.5 | <0.01 |
| Pinch strength (without blink), N | 7.8 ± 2.4 | 8.5 ± 2.4 | 6.1 ± 1.5 | <0.01 |
| Part A, sec | 30.7 ± 13.8 | 30.6 ± 10.1 | 31.1 ± 19.8 | 0.94 |
| Part B, sec | 69.1 ± 48.8 | 47.3 ± 18.5 | 116.8 ± 60.6 | <0.01 |
| The difference in the required time (Part B-Part A), sec | 38.7 ± 52.1 | 16.3 ± 15.5 | 87.6 ± 69.7 | <0.01 |

Values are mean ± SD or n (%). Part A indicates Trail Making Test part A. Part B indicates Trail Making Test part B.

**Table 2. The difference of social background, pinch strength and TMT with blink and no blink**

| | Blink during measurement | No blink during measurement | p value |
|---|---|---|---|
| n | 26 | 13 | |
| Age | 40.5 ± 22.9 | 56.3 ± 24.2 | 0.06 |
| Sex(man), n(%) | 9 (34.6) | 3 (23.1) | 0.36 |
| The number of blinks during the 5 seconds at rest, n | 0.5 ± 1.1 | 0.8 ± 0.6 | 0.33 |
| The number of blinks during the measurement of pinch strength, n | 0.7 ± 1.4 | 1.3 ± 1.4 | 0.21 |
| The number of blinks during the measurement of pinch strength without blink, n | 0 | 1.3 ± 0.5 | <0.01 |
| Pinch strength, N | 8.1 ± 2.2 | 7.7 ± 2.8 | 0.70 |
| Pinch strength (without blink), N | 7.9 ± 2.3 | 7.6 ± 2.8 | 0.72 |
| Part A, sec | 25.6 ± 8.7 | 41.1 ± 16.4 | <0.01 |
| Part B, sec | 64.7 ± 46.3 | 78.8 ± 55.0 | 0.47 |
| The difference in the required time (Part B-Part A), sec | 38.7 ± 50.4 | 38.7 ± 58.2 | 0.996 |

Values are mean ± SD or n (%). Part A indicates Trail Making Test part A. Part B indicates Trail Making Test part B.

The elderly group was older than the young group (74.4±5.6 vs. 31.9±13.8 years, p>0.01), and no difference in age was observed between the blink and no blink groups (p=0.06).

The number of blinks during rest did not differ between the young and elderly groups (p=0.08). With restriction of blinking, 13 subjects blinked. The number of blinks during the measurement of pinch strength did not differ between the young and elderly groups regardless of the presence or absence of restriction (p≤0.13). The number of blinks during the 5 seconds at rest (0.5±1.1 vs. 0.8±0.6) or the number of blinks during the measurement of pinch strength (0.7±1.4 vs. 1.3±1.4) did not differ significantly between the blink and no blink groups (p≥0.21).

Pinch strength was lower in the elderly group than in the young group both without (6.1±1.5 vs. 8.8±2.3) and with (6.1±1.5 vs. 8.5±2.4) restriction of blinking (p<0.01). Pinch strength did not decrease from the maximum value during the 5 seconds in either group (interaction p=0.57) (Figure 1). Pinch strength did not differ between the blink and no blink groups with or without restriction of blinking (p≥0.72). Pinch strength showed no decrease from the maximum value during the 5 seconds in either group (interaction p=0.97) (Figure 2).

The time needed for Part A did not differ between the young and elderly groups (30.6±10.1 sec vs. 31.1±19.8 sec, p=0.94). The mean time needed for Part B was longer in the elderly group than in the young group (116.8±60.6 sec vs. 47.3±18.5 sec, p<0.01). When the difference in the required time (Part B-Part A) was calculated to evaluate the cognitive load of Part B compared with Part A, it was longer in the elderly group than in the young group (87.6±69.7 sec vs. 16.3±15.5 sec, p<0.01). Between the blink and no blink group, the time needed for Part A was longer in the blink group than in the no blink group (41.1± 16.4 sec vs. 25.6± 8.7 sec, p<0.01). No difference was observed in the time needed for Part B or the difference in time required between the two tests (Part B-Part A) (p≥0.47).

Binomial logistic regression analysis was performed concerning the blink group. As a result, on simple regression analysis, the percent decreases 3 seconds and 4 seconds after the beginning of the 5-second measurement of pinch strength were related to Part A (Table 3). On multiple regression analysis, the time needed for Part A, in particular, was related to blinking during the measurement of pinch strength with restriction of blinking (p<0.01).

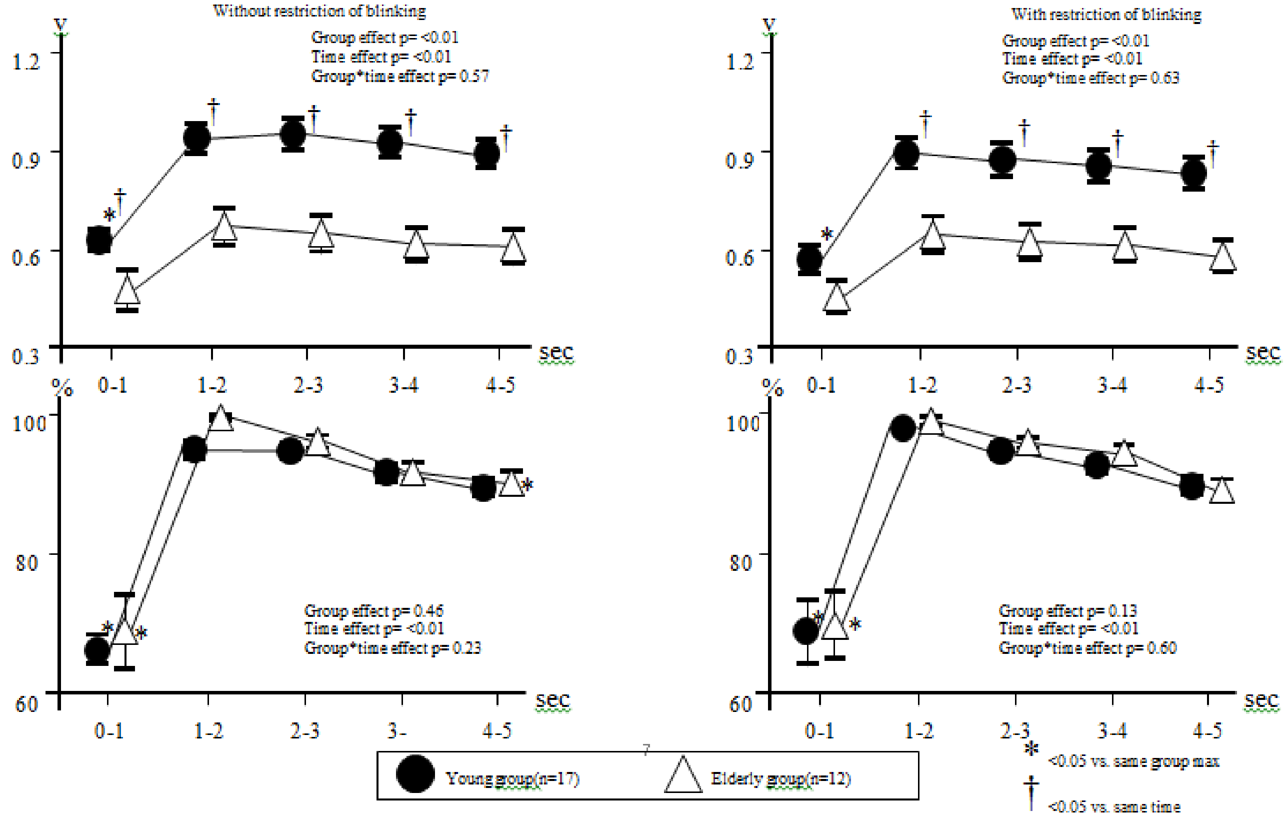


**Figure 1. Changes in pinch strength per second and rate of decrease per second in young and elderly**

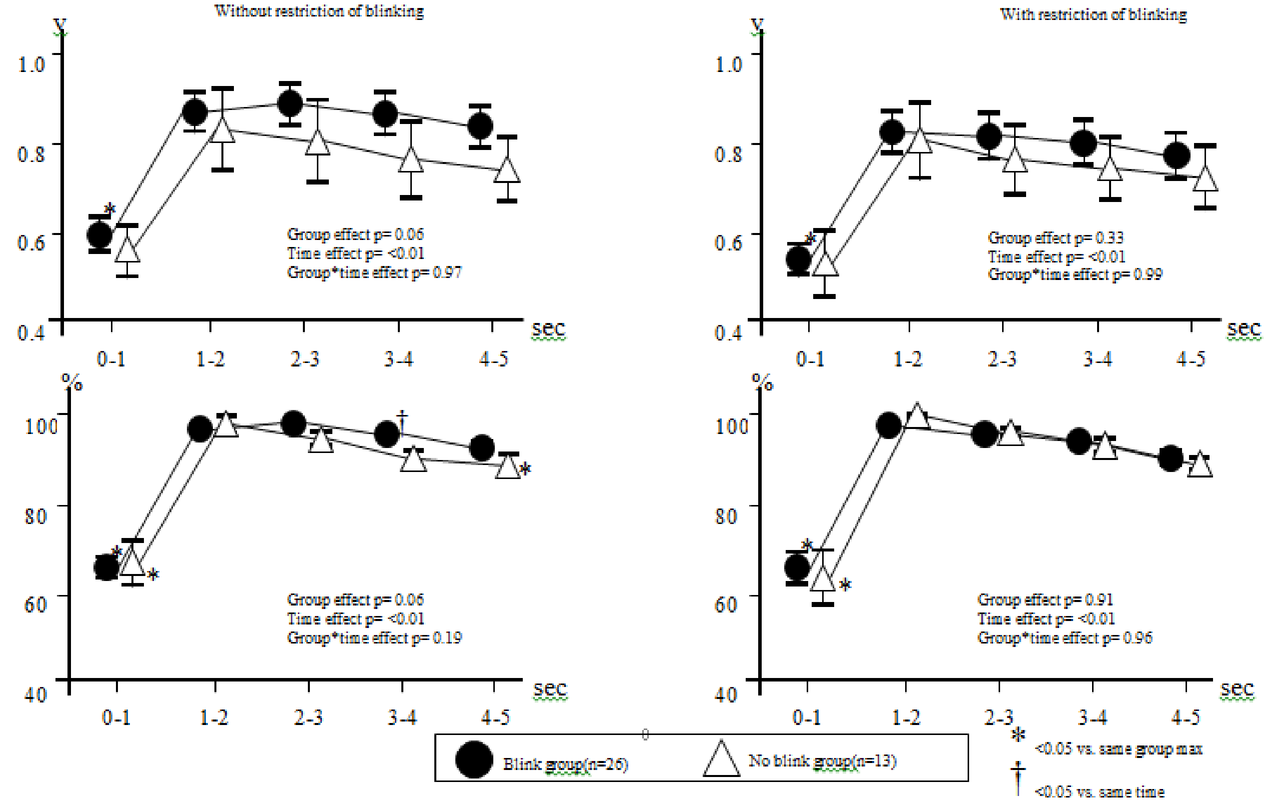


**Figure 2. Changes in pinch per second and rate of decrease per second in blink and no blink**

**Table 3. Binomial logistic regression analysis related at blink group**

| | Single regression | | Multiple regression | |
|---|---|---|---|---|
| | p value | Odds ratio | p value | Odds ratio |
| Pinch strength | 0.42 | 4.30(0.13-148.0) | | |
| The percent decreases 3 seconds | 0.03 | 0.78(0.62-0.98) | 0.07 | 0.89(0.63-1.26) |
| The percent decreases 4 seconds | 0.02 | 0.82(0.10-0.97) | 0.27 | 0.86(0.65-1.13) |
| The percent decreases 3 seconds without blink | 0.23 | 0.90(0.76-1.07) | | |
| The percent decreases 4 seconds without blink | 0.21 | 0.91(0.77-1.06) | | |
| The difference in the required time (Part B-Part A) | 0.24 | 0.989(0.97-1.01) | | |
| The time needed for part B | 0.66 | 0.996(0.98-1.08) | | |
| The time needed for part A | <0.01 | 1.13(1.03-1.24) | 0.02 | 1.13(1.01-1.26) |

Left shows values by simple regression analyses and right shows those by multivariate cox analyses adjusted for age. Part A indicates Trail Making Test part A. Part B indicates Trail Making Test part B.

## Discussion:

In this study, suppression of blinking, which is related to cognitive function and information processing, and 5-second pinch strength measurement were combined as multiple tasks, and the relationship between performance in these multiple tasks and TMT, which is a test of cognitive function, was evaluated in young and elderly individuals. The time needed for Part B was significantly shorter in the young subjects. Part B is a test of frontal lobe function, and the time needed for this test has been reported to prolong with aging [16 17]. These reports are consistent with the results of our present study and indicate an association between aging and declines in performance. Logistic regression analysis was performed between the blink and no blink groups. The results suggested an association between blinking and the time needed for Part A. Individuals who take a longer time for Part A were suggested to be more likely to blink during the measurement of pinch strength. Part A is considered to be a task of selective attention[2)] and reflects the speed of visual/motor exploration [18]. When Part A and Part B were compared, the task load was larger in Part B. From these results, the load of the multiple tasks used in this study was suggested to be light. This multiple-task test is considered to be performed in a short time with a mild burden on the subjects for screening for declines in attention functions.

## Conclusion:

On a test consisting of measurements of the maximum pinch strength and its endurance and restriction of blinking for 5 seconds, an association was observed between blinking and the time needed for Part A. This screening test can be performed safely and quickly in a seated position with a mild psychological burden. Since the subjects are expected to be more cooperative with this test, it is considered to contribute to the early detection of declines in cognitive function.

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