行政院國家科學委員會專題研究計畫 成果報告

輕觸對人體平衡之促進機轉的探討及其相關應用(第 2 年)
研究成果報告(完整版)

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計 畫 主 持 人 ： 陳惠雅
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計畫參與人員： 碩士班研究生-兼任助理人員：彭雅祺

報 告 附 件 ： 國外研究心得報告

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中 華 民 國 101 年 11 月 14 日

中 文 摘 要 ： 臨床工作人員常建議平衡損傷的病人訂購行走輔具，並教導他們如何正確地使用這些輔具；然而行走輔具幫助促進功能的完整機轉還沒有被系統化地加以研究。過去有許多研究發現手指輕觸可以幫助穩定姿勢，根據手指剪力與姿勢晃動之間的正相關，學者推論輕觸效應源於手指的體感覺提供了有關姿勢晃動的訊息。然而，作者進行文獻回顧的結果發現了兩個關於輕觸機轉的問題。第一，此領域的典型研究設計侷限於前後與左右平面的不穩定度非常不平均的足部擺位，此外，過去研究發現手指剪力與姿勢晃動之間的正相關以及手指輕觸的姿勢穩定效果只出現在最不穩的那個平面。第二，過去輕觸的研究都只使用持續輕觸力，並沒有探討到臨床上可能使用的間歇輕觸力。因此本計畫完成了兩個實驗的進行。在第一個實驗中收集了十六位健康年輕人，受試者在雙腳併攏-具平均的前後與左右平面不穩定度- 的站立姿勢下，手指輕觸一個參考姿勢晃動程度的介面，這個介面在一個或兩個平面上與姿勢同步晃動。研究結果發現，姿勢晃動會隨著參考姿勢晃動的平面增加而加大的預期並不被支持，顯示手指輕觸的姿勢穩定效果不具平面特定性。在第二個實驗中收集了十位健康年輕人，受試者閉眼在腳尖貼腳跟的姿勢下站立，根據高低音的指示變化手指輕觸或不輕觸一個固定的介面。研究結果發現，。研究結果發現，只要輕觸時間超過一秒就有穩定姿勢的效果，並且只要輕觸時間超過 0.5 秒就會在之後的六秒鐘發揮穩定姿勢的效果。

中文關鍵詞： 手指輕觸；姿勢晃動；站立平衡；體感覺；機轉

英 文 摘 要 ： Clinicians often subscribe walking aids for patients with impaired balance and instruct them how to use these aids properly； however, the full mechanisms these walking aids improve function are not well understood. Previous research has found that a light finger touch stabilizes posture. Based on the positive correlation found between hand shear force and postural sway, it was proposed that the touch effect comes from somatosensory information from finger which provides information of postural sway. A literature review, however, reveals that the mechanisms of the stabilization effect of light touch are not fully clear. Firstly, the typical paradigm was limited to feet positions with an uneven distribution of inherent instability in the anterior-posterior (AP) and medio-lateral (ML) planes.

Furthermore, the correlation between fingertip forces and postural sway was limited, or mostly distributed, to the plane with the greatest instability； and so were the postural stabilization effects. Secondly, the effects of light touch cues on body sway have always been investigated with touch kept constant but not with intermittent touch. Thus, this project has completed two experiments. In Experiment I, 16 healthy participants were asked to stood in feet-together stance with instability evenly distributed in the AP and ML planes. A sway-referenced design manipulated the touch surfaces to move in synchrony with actual postural sway in one plane or in two planes. The prediction of stepwise increased postural sway in the sway-referenced plane(s) was not supported, suggesting that the light touch effects do not come from plane-specific sensory cues of postural sway. In Experiment II, 10 healthy participants stood in a heel-to-toe posture with eyes closed. They were asked to alternate their index finger position between no touching and touching on a strain gauge at the waist level in response to low- and high-pitched auditory cues. The results showed that sway was reduced during light touch intervals with durations greater than 1s. During the 6 second no-touching periods, reductions in sway persisted after light touch withdrawal. Interestingly, this effect was also found for light touch periods greater 0.5s.

英文關鍵詞： finger touch； postural sway； standing balance； somato sensation； mechanism

行政院國家科學委員會補助專題研究計畫　　　　□ 成果報告 □期中進度報告

（計畫名稱）

輕觸對人體平衡之促進機轉的探討及其相關應用

計畫類別：□ 個別型計畫 □ 整合型計畫

計畫編號：NSC 98-2314-B-040 -006 -MY2

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計畫主持人：陳惠雅

共同主持人：羅世忠

計畫參與人員：彭雅祺

成果報告類型(依經費核定清單規定繳交)：□精簡報告 □完整報告

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□出席國際學術會議心得報告及發表之論文各一份

□國際合作研究計畫國外研究報告書一份

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執行單位：中山醫學大學物理治療學系

中 華 民 國 2012 年 11 月 13 日

（一） 中文摘要。

臨床工作人員常建議平衡損傷的病人訂購行走輔具，並教導他們如何正確地使用這些輔具；然而行走輔具幫助促進功能的完整機轉還沒有被系統化地加以研究。過去有許多研究發現手指輕觸可以幫助穩定姿勢，根據手指剪力與姿勢晃動之間的正相關，學者推論輕觸效應源於手指的體感覺提供了有關姿勢晃動的訊息。然而，作者進行文獻回顧的結果發現了兩個關於輕觸機轉的問題。第一，此領域的典型研究設計侷限於前後與左右平面的不穩定度非常不平均的足部擺位，此外，過去研究發現手指剪力與姿勢晃動之間的正相關以及手指輕觸的姿勢穩定效果只出現在最不穩的那個平面。第二，過去輕觸的研究都只使用持續輕觸力，並沒有探討到臨床上可能使用的間歇輕觸力。因此本計畫完成了兩個實驗的進行。在第一個實驗中收集了十六位健康年輕人，受試者在雙腳併攏-具平均的前後與左右平面不穩定度- 的站立姿勢下，手指輕觸一個參考姿勢晃動程度的介面，這個介面在一個或兩個平面上與姿勢同步晃動。研究結果發現，姿勢晃動會隨著參考姿勢晃動的平面增加而加大的預期並不被支持，顯示手指輕觸的姿勢穩定效果不具平面特定性。在第二個實驗中收集了十位健康年輕人，受試者閉眼在腳尖貼腳跟的姿勢下站立，根據高低音的指示變化手指輕觸或不輕觸一個固定的介面。研究結果發現，。研究結果發現，只要輕觸時間超過一秒就有穩定姿勢的效果，並且只要輕觸時間超過 0.5 秒就會在之後的六秒鐘發揮穩定姿勢的效果。

（二） 英文摘要。

Clinicians often subscribe walking aids for patients with impaired balance and instruct them how to use these aids properly; however, the full mechanisms these walking aids improve function are not well understood. Previous research has found that a light finger touch stabilizes posture. Based on the positive correlation found between hand shear force and postural sway, it was proposed that the touch effect comes from somatosensory information from finger which provides information of postural sway. A literature review, however, reveals that the mechanisms of the stabilization effect of light touch are not fully clear. Firstly, the typical paradigm was limited to feet positions with an uneven distribution of inherent instability in the anterior-posterior (AP) and medio-lateral (ML) planes. Furthermore, the correlation between fingertip forces and postural sway was limited, or mostly distributed, to the plane with the greatest instability; and so were the postural stabilization effects. Secondly, the effects of light touch cues on body sway have always been investigated with touch kept constant but not with intermittent touch. Thus, this project has completed two experiments. In Experiment I, 16 healthy participants were asked to stood in feet-together stance with instability evenly distributed in the AP and ML planes. A sway-referenced design manipulated the touch surfaces to move in synchrony with actual postural sway in one plane or in two planes. The prediction of stepwise increased postural sway in the sway-referenced plane(s) was not supported, suggesting that the light touch effects do not come from plane-specific sensory cues of postural sway. In Experiment II, 10 healthy participants stood in a heel-to-toe posture with eyes closed. They were asked to alternate their index finger position between no touching and touching on a strain gauge at the waist level in response to low- and high-pitched auditory cues. The results showed that sway was reduced during light touch intervals with durations greater than 1s. During the 6 second no-touching periods, reductions in sway persisted after light touch withdrawal. Interestingly, this effect was also found for light touch periods greater 0.5s.

壹、報告內容

一、前言

While maintaining standing balance, somatosensory information is usually derived from the lower extremities. Sensory information can also be made available from the upper extremities if a person is touching a wall, handrail, or a cane with their hand. A light contact of the index finger with a surface has been found to be effective in reducing postural sway, even though the force level applied is far below that which is necessary to provide mechanical support (Jeka, 1997).

While instructing participants to stand with a heel-to-toe posture and lightly touch a stationary object, Jeka and Lackner (1994) used the cross-correlation function to probe the temporal and spatial relationships between hand shear force and the center of pressure in the medio-lateral (ML) plane. Clapp and Wing (1999) tested the same paradigm in the anterior-posterior (AP) plane with a normal stance. What was common between their findings was a positive correlation coefficient and a time lag (i.e. changes in force at the fingertip led changes in the center of pressure). These results were interpreted in the following manner: sensory input from touch, such as tactile stimulation arising from shear force at the finger, was used to anticipate and counteract postural sway, with the time lag providing an estimate of the control system delays.

Experiment I

A literature review discloses that the typical paradigm in testing the light touch effect was limited to feet positions with a very uneven distribution of inherent instability, i.e. heel-to-toe stance and normal stance with instability mainly in the ML and AP plane respectively (Clapp & Wing, 1999; Jeka & Lackner, 1994; Lackner, Rabin, & DiZio, 2001; Rabin, Bortolami, DiZio, & Lackner, 1999; Reginella, Redfern, & Furman, 1999). It is further disclosed that the correlation between fingertip forces and postural sway was limited, or mostly distributed, to the plane with the greatest instability (Clapp & Wing, 1999; Jeka & Lackner, 1994). Moreover, while most studies reported postural sway data only in the plane with the greatest instability, Clapp and Wing (1999) reported the touch effect occurring in the AP but not ML plane with normal stance, suggesting that somatosensory information from finger affects postural sway only in the plane of the greatest instability. From the above literature review, one might propose that the postural stabilization effects provided by touch depend on availability of plane-specific cues of sway-related information.

However, is the above proposition true if a different paradigm is adopted? One way to test this proposition is to remove sway-related information from touch in either AP or ML plane, and then to measure the degree of postural stabilization in both planes when the adopted standing posture is equally unstable in the AP and ML planes. This study was conducted to test this dual-plane paradigm. A feet-together position was chosen for its inherent instability in both AP and ML planes (Vuillerme & Nougier, 2003). Experimental conditions were manipulated by using a sway-referenced design, such that online information regarding postural sway from finger touch was available either in both planes (*stable* touch surface), almost only in the ML plane (*AP sway-referenced* touch surface), or nearly in no plane (*AP-ML sway-referenced* touch surface). It was predicted that, if the light touch effect comes from plane-specific sensory cues of postural sway, there would be increased postural sway in the AP plane under the *AP sway-referenced* condition compared to the *stable* condition, and in the ML plane under the *AP-ML sway-referenced* condition compared to the *AP sway-referenced* condition.

Reginella et al. (1999) and Rogers et al. (2001) have conducted light touch experiments with similar sway-referenced designs. In the study of Rogers et al. (2001), a control experiment was conducted using a one-axis servomotor that moved in close synchrony with postural sway so as to eliminate sway-related information from touch. In the study of Reginella et al. (1999), an equipment produced by the NeuroCom International Inc. was used to produce a sway-referenced surface. In both of the above studies, the results were in accordance with the first part of the predictions of this study. The two studies, however, adopted a normal stance position and lacked the dual-plane paradigm to examine the light touch effect in both AP and ML planes.

Experiment II

Previous studies on the effect of light skin contact on body sway have until now focused on steady state contact. However, previous studies on the effect of light skin contact on body sway have focused on steady state contact. The only exception was the study by Rabin and colleagues (2006), who probed the time course of the light touch effect with a paradigm in which light fingertip touch was established abruptly. They examined the integration of fingertip afferent information into the postural control loop following a transition from a no-touch state to a touch state and reported that the reduction in body sway showed a time constant of 1.6 seconds. This finding provides evidence for rapid postural stabilization provided by finger touch. However, the study by Rabin and colleagues did not report whether the light touch effect requires a minimum period of exposure before sway is reduced or whether short periods of intermittent light touch generate after-effects before sway returns to normal.

二、研究目的

Experiment I aimed to examine whether postural stabilization effects of light finger touch come from plane-specific sensory cues of sway-related information. The aim of Experiment II was to investigate how a sequence of light touch periods of short duration (light touch periods followed by no-touch intervals) affects postural sway during and after each touch period and across a whole trial.

三、研究方法

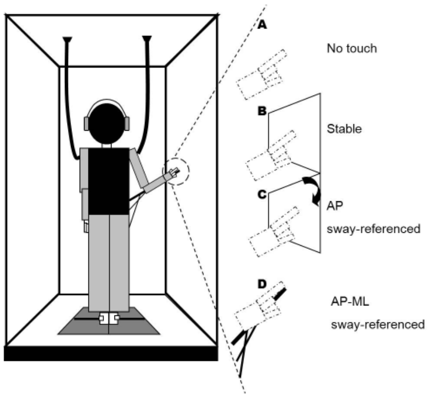
Experiment I

Participants

Sixteen healthy adults (10 females and 6 males) gave their written consents to participate in the study. Their average age was 23.17 ± 2.05 years, the average height was 163.59 ± 8.29 cm, and the average weight was 58.44 ± 11.46 kg. All participants were right-handed and reported themselves free from any neurologic or orthopedic disease. The Institutional Review Board of the Chung Shan Medical University Hospital approved the study and all associated activities were in accordance with the Declaration of Helsinki.

Apparatus

A Smart Balance Master system (NeuroCom International, Inc., Clackamas, OR, USA), with the mounted forceplate set in still mode, was responsible for the recording of the center of pressure in both anterio-posterior (AP) and medio-lateral (ML) planes at 100 Hz. It was also used to generate two of the experimental conditions. In the *stable* condition, the area surrounding the Smart Balance Master was kept still. In the *AP sway-referenced* condition, a mounted servomotor driven by the participant's postural sway, as calculated with the center of pressure recording and data of individual body height, moved the surrounding area in the AP plane. For body sway rates below 0.3 Hz, the servomotor system is highly accurate at estimating both the amplitude and time of the sway angle. Thus, as the participant swayed, the surrounding area moved accordingly so that although tactile sensation was still available from the finger, online information regarding postural sway in the AP plane was largely reduced from touch. In order to minimize the operation noise, stereo headphones were provided throughout the experiment.



In the *AP-ML sway-referenced* condition, a coat hanger (diameter 2 mm) was folded into an L-shape with an angle of 120°. The longer side stretched out 41.5 cm to form the touch surface, and the shorter side (length 25.5 cm) was folded elliptically and attached firmly on the right side of the participant's pelvis. During quiet standing, the human body sways like an inverted pendulum and the sway of the pelvis represents postural sway near perfectly. Thus, this condition created a touch surface that moved in close synchrony with postural sway, such that sway-related information in both AP and ML planes was largely eliminated.

Therapeutic putty (#5072, Sammon's Preston, Bolingbrook, IL, USA), of approximately 1 cm in cubicle, was used at the interface between fingertip and touch surface. This ensured that participants were only touching a small area lightly because its shape deformed if the normal force from small weights exceeded a level of approximate 0.5 N.

Protocols

After fitting the folded coat hanger, participants stood with feet together without shoes and socks on the forceplate. Their ankles were aligned with the axis of rotation of the forceplate for sway-referencing. They then put on the headphones and closed their eyes. For safety reasons, they also wore a suspended harness attached to the Smart Balance Master throughout the experiment.

The four conditions included a controlled *no touch* condition and three touch surfaces which were *stable, AP sway-referenced, and AP-ML sway-referenced*. In all conditions, participants were asked to hold their right arm in a comfortable and outstretched configuration at about waist height, which was made similar across conditions. Apart from the control condition of no touch, participants were asked to maintain their index finger lightly touching the putty, which was attached either to the area surrounding the Smart Balance Master or to the end point of the folded coat hanger.

Participants practiced each condition to become familiar with the protocol prior to formal data collection. There were 6 trials for each condition, and the order of the summed 24 trials was randomized. Each trial lasted for 30 seconds with data collection occurring only in the last 20 seconds. After completing each trial, the experimenter checked if the shape of the putty was deformed, after which participants were allowed to rest a minute before the next trial began.

Data analysis and statistics

The primary measure of interest was the variability of postural sway. Center of pressure data in the AP (CoP_{AP}) and ML (CoP_{ML}) planes were analyzed using a custom program written in Labview 8.5 (National Instrument, Austin, TX, USA). The data from the root-mean-square analysis after subtracting the mean was analyzed over a series of 20 non-overlapping moving windows each lasting one second (mwRMS). Averaged mwRMS of CoP_{AP} and of CoP_{ML} was then derived for each condition in each participant.

$$mwRMS = \sqrt{(1/100)\sum_{i=1}^{100}(CoP_i - CoP_{mean})^2}$$

Using SPSS 14.0 software (Chicago, IL, USA), two one-way analyses of variance (ANOVAs) with three planned comparisons were performed on the mwRMS analyses of CoP_{AP} and of CoP_{ML}. The significance level was set at 0.05. Because of the possibility of a type I error, a Bonferroni adjustment was used for multiple comparisons.

Experiment II

Participants

Ten healthy adults (eight females and two males; average age 20.7 SD 2.87 years) gave their written informed consent, as approved by the Institutional Review Board of Chung Shan Medical University Hospital, to participate in the study. All of the participants reported no musculoskeletal or neurological abnormalities that could have influenced their standing balance. Two of the participants self-reported being left-handed, whereas the other participants were right-handed.

Apparatus

To augment the lateral instability of the body, participants stood with their shoes and socks removed in a modified heel-to-toe stance (one heel touching the side of the big toe of the other foot) on a force plate (Bertec FP4550-08, USA), which measured the six components of the ground reaction forces and moments to determine the anterior-posterior and medio-lateral components of the center of pressure (COP). In response to a high- or low-pitched auditory cue, participants either made fingertip contact with a circular touch plate (5 cm diameter) mounted on a stand at waist level to the front right of the participants or withdrew contact from the plate. A dual-axis strain gauge (RMAX SN110336-1, Taiwan) measured the normal and lateral shear forces applied to the touch plate. Three infrared cameras (MotionAnalysis HAWK, USA) captured the motion of two reflective markers, one placed on the tip of the participant's index finger and one on the edge of the touch plate. All signals were sampled at 100 Hz.

A single trial lasted 46 seconds and consisted of a 6-second baseline no-touching period *(baseline NT)* followed by five touching periods of 0.5-, 1-, 1.5-, 2-, and 5-second durations *(0.5T, 1T, 1.5T, 2T, 5T)* in a pseudo-randomized order. Each of the five touch periods was followed by a 6-second no-touching period *(after 0.5NT, after 1NT, after 1.5NT, after 2NT, after 5NT)*. The beginning and the end of each trial were cued separately to indicate the start and end of data collection.

Procedure

After the height of the stand was adjusted to each participant's waist level, the participants were asked to hold the index finger of their dominant hand above the touch plate while keeping their outstretched arm in a comfortable posture. Participants were then instructed to close their eyes and to stand relaxed but as still as possible without speaking.

Trials were begun when the participants indicated that they were ready. On hearing a high-pitched tone, participants flexed their index finger at the metacarpal-phalangeal joint to initiate light finger contact. On a low-pitched tone, participants extended their index finger just above the touch plate. Practice trials were conducted to ensure that participants were familiar with the experimental protocol. Participants performed five standing trials and were allowed to rest for thirty seconds between trials.

Data analysis and statistics

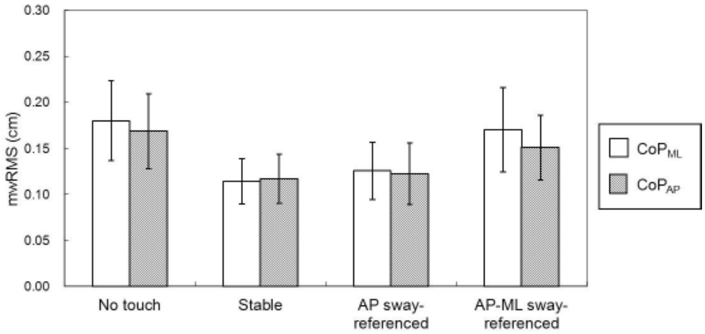
All data underwent 6 Hz Butterworth (4th-order dual-pass) low-pass filtering. According to the vertical touch force detected by the strain gauge, all trials were segmented into eleven no-touch and touch sections and further divided into bins of approximately 500 ms duration to standardize the number of data points for the sway measure extraction. That is, the 6-second no-touching periods including the baseline period were evenly divided into twelve bins, and the touching periods of 0.5-, 1-, 1.5-, 2-, and 5-second duration were evenly divided into one, two, three, four, and ten bins, respectively. Because participants showed variable on and off touch response latencies to the auditory cue, the touching and no-touching periods could be shorter or longer than the externally cued periods, resulting in bins of approximately 500 ms width. For the baseline period, only the four bins prior to the first touch were analyzed.

Sway was quantified in terms of the mean absolute amplitude (Rabin, DiZio, & Lackner, 2006), $\overline{A}$, of the center of pressure fluctuations in the medio-lateral plane (COP_{ml}): $\overline{A} = \frac{1}{N_t}\sum_{i=1}^{N_t}|x_i - \overline{x}|$,where N_t is the number of data points in each 500-ms bin. Mean absolute amplitudes, $\overline{A}$, were calculated separately for the touching and no-touching periods across the respective bins and the five trials for each duration condition and each participant. First, using SPSS 18.0 software (Chicago, IL, USA), two repeated-measures one-way analyses of variance (ANOVA) were conducted to compare the touch duration conditions with respect to an effect and aftereffect in sway with the significance level set at .05. We reported p-values following the Brown-Forsythe correction if unequal variance was encountered between factor levels as determined by Levene's test ($p < .25$). ANOVAs were followed by simple contrast tests to compare each duration condition and *baseline NT*, with the significance level set at .01. Finally, to examine whether recurring light touch would result in longer-term postural adaptation across a trial despite interruptions, the trend of sway across the no-touch periods in temporal sequences was examined by another one-way ANOVA with a significance level set at .05.

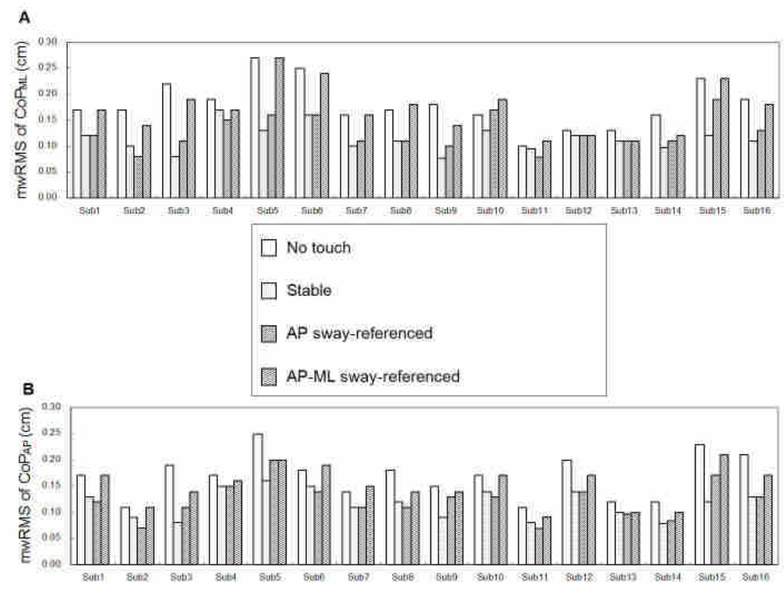
四、結果與討論（含結論與建議）

Experiment I

Participants could not subjectively feel whether or not there was deformation of the putty, but according to the examination of the experimenter, no trial had to be repeated. The following figure shows the averaged mwRMS value as a function of condition. The ANOVAs performed for CoP_{ML} ($F(3,45) = 29.956$, $p < 0.001$) and for CoP_{AP} ($F(3,45) = 39.113$, $p < 0.001$) both resulted in condition effects. Comparing the condition of *stable* touch surface relative to the condition of *no touch*, the light touch effect was equally evident for both CoP_{ML} (37% reduction, $F(1,15) = 37.374$, $p < 0.001$) and CoP_{AP} (31% reduction, $F(1,15) = 44.893$, $p<0.001$) measurements.

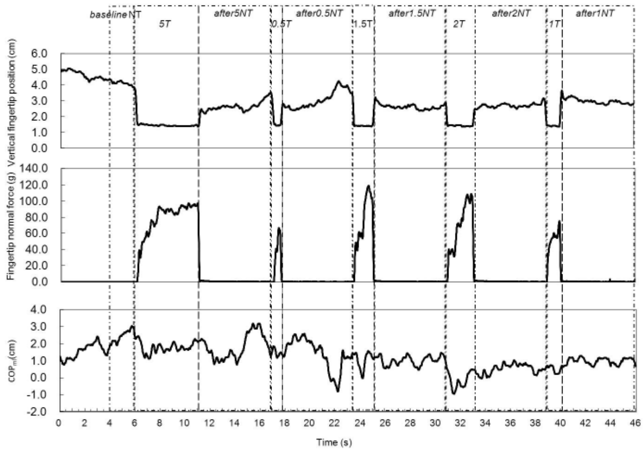


The main analyses of interest were the comparisons between conditions with an increased sway plane of touch surface. It can be seen that there was no difference in mwRMS values comparing touch surface conditions of *stable* versus *AP sway-referenced*. This was true for either CoP_{ML} ($F(1,15) = 3.599$, $p = 0.077$) or CoP_{AP} ($F(1,15) = 1.052$, $p = 0.321$) measurement. When comparing touch surface conditions of *AP-ML sway-referenced* versus *AP sway-referenced*, the mwRMS significantly increased for both CoP_{ML} ($F(1,15) = 32.99$, $p < 0.001$) and CoP_{AP} ($F(1,15) = 49.796$, $p < 0.001$) measurements. An inspection of the individual data revealed the same trend for the above comparisons in all participants.

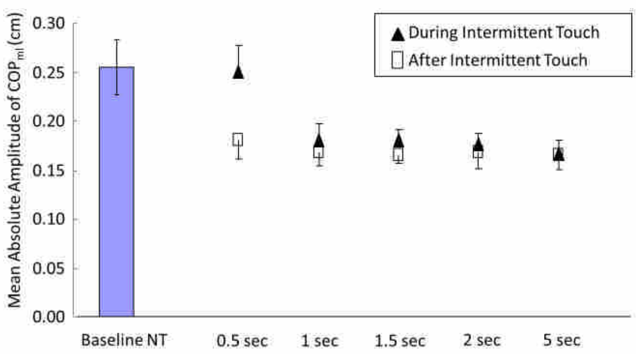


Experiment II

Overall, 13 trials out of 50 (26%) were excluded from data analysis because these trials contained either a single segment with touch greater than 1.4N or an event in which the finger accidentally missed contact with the touch plate when touch had to be established. Three to five trials for each participant were available for analyses. Delays due to participants' latencies in response to the auditory cue meant that the actual touching periods may have been shorter or longer than the set periods. The actual durations for the conditions of *0.5T, 1T, 1.5T, 2T,* and *5T* were 726 ms (range 540-950), 1162 ms (range 920-1380), 1668 ms (range 1500-1800), 2197 ms (range 1960-2440), and 5192 ms (range 4900-5500), respectively. These actual touch durations deviated from the set periods, but the specific ranges showed no overlap between duration conditions. The following figure represents the raw COP_{ml} fluctuations and the touch force component from a single trial of a single participant.

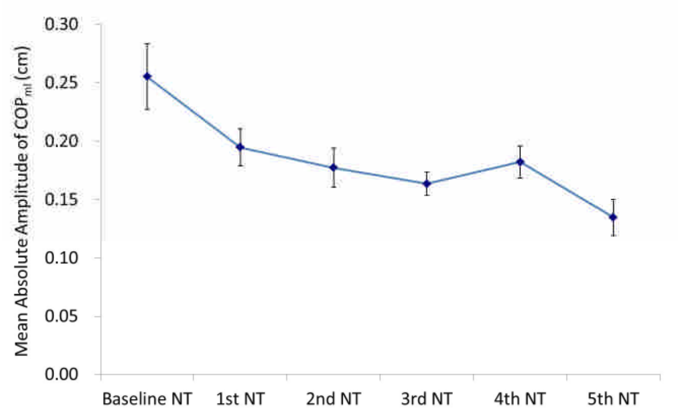


The following figure shows $\overline{A}$ during the touching and no-touching periods as a function of the trial segments representing the touch duration conditions. The distributions of $\overline{A}$ during *baseline NT* and the five touch durations *(0.5T, 1T, 1.5T, 2T*, and *5T;* filled triangles*)* were normal (*p* = .276) and had unequal variance, as indicated by Levene's test (*p* = .081). The one-way ANOVA on $\overline{A}$ of the touching periods showed a significant effect of light touch duration ($F_{5,34.23}$ = 4.29, *p* = .004, partial η^2 = .284). The simple contrasts, in comparison to *baseline NT*, revealed significant sway reductions for *1T, 1.5T, 2T*, and *5T* (all *p* < .009).



The distributions of $\overline{A}$ of *baseline NT, after0.5T, after 1T, after1.5T, after2T,* and *after5T* (open squares in the above figure) were not normal (*p* = .009) and had unequal variance, as indicated by Levene's test (*p* = .159). The one-way ANOVA on $\overline{A}$ of the no-touching periods also showed a significant effect of light touch duration ($F_{5,33.64}$ = 3.783, *p* = .008, partial η^2 = .259), which was confirmed by the Kruskal-Wallis non-parametric test (p = .015). The simple contrasts, in comparison to *baseline NT*, revealed significant sway reductions for *after0.5NT, after1NT, after1.5NT, after2NT,* and *after5NT* (all $p < .005$).

The following figure illustrates the evolution of $\overline{A}$ across the no-touching periods from the baseline first no-touching period until the fifth and final no-touching period, which showed unequal variance according to Levene's test (p = .179). The one-way ANOVA performed on the no-touching periods as a function of time revealed a significant linear trend of decrement over the entire trial ($F_{5,34.14}$ = .001, p = .321).



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參、計畫成果自評

本研究計劃為計畫主持人之第二個研究計劃，此次嘗試的研究議題為基礎的動作控制理論，雖然完成度頗佳，但是在有限的資源下所募集的參與研究人員多為復健背景，對於此議題較缺乏相關知識，這個部分所花費的時間與心力較預期多，此為意料之外。目前正積極撰寫文章準備發表中。

國科會核定 154000 元(赴國外差旅費 70000 元及出席國際會議差旅費 84000 元)，己支用出席國際會議差旅費 84000 元，因時間無法配合至國外出差，故繳回國外差旅費 70000 元。

本人於 2011 年 6 月 20-23 日出席於荷蘭阿姆斯特丹舉辦之「第 16 屆世界物理治療師協會國際研討會」(16th International WCPT congress)，茲簡述此研討會如下。

1. 自費專題課程「Neurology- Lifespan motor control」：整理動作控制的生理與評估方式，簡介了幾個常用關的評估量表，包含 ARAT、Wolf Motor Function Test 等，最後整理了目前臨床使用的介入方式以及實例影片，包含 NMES、taping、splinting 等，是一個非常實用的課程。
2. 自費專題課程「Walking speed assessment」：這是一個新興的研究主題，針對臨床常用的步行速度評估，講解其臨床意義，最重要的是講師本身的研究團隊進行了許多相關研究，幫助聽眾看見一個簡單的測試背後所提供的豐富訊息，是一個非常實用的課程。
3. 論文口頭報告：分爲多項主題，由報告內容可以看出關於注意力、動作學習、老人族群等主題仍爲熱門的研究領域。
4. 論文海報展示：也是本人此次報告的方式，發表了兩篇摘要「Postural stability effects during and after intermittent light finger touch」「Hierarchy of higher-level physical functions: A longitudinal investigation on a nationally representative population」，與來自日本和英國的學者有非常熱烈的討論，也刺激本人在將來投稿的寫作上很多的想法。

國科會補助計畫衍生研發成果推廣資料表

日期:2012/11/14

國科會補助計畫	計畫名稱: 輕觸對人體平衡之促進機轉的探討及其相關應用
	計畫主持人: 陳惠雅
	計畫編號: 98-2314-B-040-006-MY2　　　　學門領域: 復健科

無研發成果推廣資料

98 年度專題研究計畫研究成果彙整表

計畫主持人：陳惠雅			計畫編號：98-2314-B-040-006-MY2				
計畫名稱：輕觸對人體平衡之促進機轉的探討及其相關應用							
成果項目			量化			單位	備註（質化說明：如數個計畫共同成果、成果列為該期刊之封面故事...等）
			實際已達成數（被接受或已發表）	預期總達成數(含實際已達成數)	本計畫實際貢獻百分比		
國內	論文著作	期刊論文	0	1	0%	篇	0 努力撰寫中
		研究報告/技術報告	0	0	100%	篇	
		研討會論文	0	0	100%	篇	
		專書	0	0	100%		
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%	件	
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（本國籍）	碩士生	1	1	100%	人次	1
		博士生	0	0	100%	人次	
		博士後研究員	0	0	100%	人次	
		專任助理	0	0	100%	人次	
國外	論文著作	期刊論文	0	2	0%	篇	0 努力撰寫中
		研究報告/技術報告	0	0	100%	篇	
		研討會論文	2	2	100%	篇	2
		專書	0	0	100%	章/本	
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%	件	
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（外國籍）	碩士生	0	0	100%	人次	
		博士生	0	0	100%	人次	
		博士後研究員	0	0	100%	人次	
		專任助理	0	0	100%	人次	

其他成果 (無法以量化表達之成果如辦理學術活動、獲得獎項、重要國際合作、研究成果國際影響力及其他協助產業技術發展之具體效益事項等，請以文字敘述填列。)	無

	成果項目	量化	名稱或內容性質簡述
科教處計畫加填項目	測驗工具(含質性與量性)	0	
	課程/模組	0	
	電腦及網路系統或工具	0	
	教材	0	
	舉辦之活動/競賽	0	
	研討會/工作坊	0	
	電子報、網站	0	
	計畫成果推廣之參與（閱聽）人數	0	

國科會補助專題研究計畫成果報告自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估

   ■達成目標

   □未達成目標（請說明，以 100 字為限）

   　　□實驗失敗

   　　□因故實驗中斷

   　　□其他原因

   說明：

2. 研究成果在學術期刊發表或申請專利等情形：

   論文：□已發表 □未發表之文稿 ■撰寫中 □無

   專利：□已獲得 □申請中 ■無

   技轉：□已技轉 □洽談中 ■無

   其他：（以 100 字為限）

3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）（以 500 字為限）

   The proposed research could be valued from both perspectives of motor control and clinical use. From the perspective of motor control, it is interesting to know the fundamental mechanism(s) of light touch effects and their efficacy in various contexts. The results of this proposed project might help to broaden our knowledge of postural control, which could alternatively be viewed as fundamental for numerous daily life tasks that are super-ordinate to the pure control task of posture. In daily living, control of posture is usually not the main task goal, but is functionally linked to the performance of other supra-postural tasks. Thus, the results of this proposed project might also help to provide clinical insights into to the rehabilitation of people suffering from impaired postural control.