科技部補助專題研究計畫成果報告
期末報告

行走任務學習過程中雙重作業虧損之變化：中風病患使用單腳拐者之長期研究(第2年)

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報 告 附 件 ： 移地研究心得報告

本研究具有政策應用參考價值：■否 □是，建議提供機關
（勾選「是」者，請列舉建議可提供施政參考之業務主管機關）
本研究具影響公共利益之重大發現：□否 □是

中 華 民 國 107 年 10 月 31 日

中 文 摘 要 ： 研究背景　學習理論認為獲得新的動作任務過程會由認知期最後進入到自動化，因此，雙重作業虧損(dual-task cost)應可作為動作學習表現是否已進入自動化的一項指標。然而，即使過去許多雙重作業虧損的研究皆發現執行行走任務需要一定程度的注意力，極少研究應用雙重作業虧損指標於行走任務的學習研究中。例如，中風病患在學習使用拐杖的行走任務時，其雙重作業虧損的學習曲線為何？

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研究方法　本研究追蹤中風病患使用單腳拐或四角拐者，在初次挑戰行走任務之初期，於第0、1、2、4及8週進行施測，第0週為治療師判斷病患拿拐杖可以獨立行走7.3公尺。單/雙重任務測試，個別執行及同時執行拿枴7.3公尺行走任務及算數任務，算術從1-100之間隨機選擇數字連續減1(簡單)和減3(困難)。計算行走速度的雙重作業虧損：[（簡單雙重任務表現-困難雙重任務表現）/簡單雙重任務表現]x100%。另外從斜率看雙重作業虧損每天的變化量：（最後一週雙重作業虧損-第0週雙重作業虧損）/（最後一週天數-第0週天數）。此外，本研究也比較剛學會不拿拐杖行走之中風病患的雙重作業虧損差異比值，在拿拐杖和不拿拐杖之間是否有差異。

研究結果　（一）12位住院中風患者，年齡平均60.4±10.8歲，性別(男性8人/女性4人)，中風發生天數平均73.1±31.0天。11位患者的第0週雙重作業虧損為正值，表示大部分患者在亞急性期初學習拐杖時都較需注意力資源。前3週之福格邁爾-下肢分數（P=0.001）、巴氏量表（P=0.001）、計時起走測試時間（P=0.015）、簡單（P=0.012）及困難（P=0.004）雙重任務行走速度隨著時間顯著進步，雙重作業虧損則無顯著進步（P=0.459）。從斜率看雙重作業虧損每天的變化，有8位患者呈現進步的趨勢，四位第0週雙重作業虧損本來就不大的病患較沒有呈現進步的趨勢。雙重作業虧損與中風發生天數呈現顯著中度負相關（r=-0.499，P<0.001），表示隨著時間恢復與復健將可能會使的中風患者可以越來越有效率的分配注意力資源並且同時執行兩項任務。(二)目前已經完成四位剛學會不拿拐杖行走之中風病患之資料分析，拿拐杖的雙重任務虧損指標普遍比不拿拐杖大，表示拿枴杖行走有較高的注意力需求；此外放拐杖的天數愈久，不拿拐杖的雙重任務虧損(相較於拿拐杖行走)愈小。

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few researches adopted DTC in longitudinal studies of gait training. For example, does DTC gradually decline over the rehabilitation course of stroke survivors who just start using a cane to assist walking?

Objectives: This project aims to longitudinally observe the changes of attention demands, by using the index of DTC, over the learning course of stroke survivors who just start using a cane to assist walking. We hypothesize that, during the studying three months with advances of walking skills, the index of DTC will gradually decline.

Methods: This project followed up patients with stroke, at 0, 1, 2, 4, and 8st week, in the early stage when they initially received their walking training with a single or quad cane. The 0 week was defined as when their physical therapists judged that they could walk with a cane by themselves for 7.3 meters. Participants were tested for single- and dual-task walking conditions; the latter involved simultaneous execution of continuous subtraction by one (low task) or three (high task) from a random number between one and a hundred. The index of DTC of walking velocity was [(low dual task-high dual task)/low dual task]×100%. In addition, we also compared their DTC index, while some stroke patients first learned to walk without the cane, between the condition of walking with cane and walking without cane.

Results: (1) 12 patients, 8 males and 4 females with average age 60.4±10.8 years and average stroke onset days 73.1±31.0, were tested more than once. The DTC in 11 patients were positive at the 0 week, indicating that most subacute patients with stroke demand more attentional resource when they initially learn to walk with a cane. In the first three weeks, the Fugl-Meyer lower extremity (P=0.001), the Barthel Index (P=0.001), the Timed Up and Go test (P=0.015), and the low (P=0.012) and high (P=0.004) dual task walking velocity significantly improved over time. But the dual-task cost of walking velocity did not (P=0.459). Eight patients showed a trend of improvement in the slope of daily change of dual-task cost; whereas four patients who showed little DTC at the 0 week showed less improvement. There was a significant moderately negative correlation between the dual-task cost and stroke onset days ($r=-0.499$, $P<0.001$). (2) We have completed data analyses of 4 stroke patients who just learned to walk without cane. Comparing the results between walking with cane and walking without cane, the DTC index

with cane was larger than that without cane, indicating a higher attentional demand when walking with cane. In addition, the longer the patient learned to walk without cane, the smaller the DTC index of walking without cane, relative to walking with cane.

英文關鍵詞：stroke, walk, cane, attentional demand, dual task, longitudinal follow up

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/V期末報告）

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計畫主持人：陳惠雅
共同主持人：傅書毅、陳綉儀
計畫參與人員：曹涵婷、謝雅雯

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V出席國際學術會議心得報告

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107　年 10　月 30　日

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Results: (1) 12 patients, 8 males and 4 females with average age 60.4±10.8 years and average stroke onset days 73.1±31.0, were tested more than once. The DTC in 11 patients were positive at the 0 week, indicating that most subacute patients with stroke demand more attentional resource when they initially learn to walk with a cane. In the first three weeks, the Fugl-Meyer lower extremity（P=0.001）, the Barthel Index（P=0.001）, the Timed Up and Go test（P=0.015）, and the low （P=0.012）and high （P=0.004）dual task walking velocity significantly improved over time. But the dual-task cost of walking velocity did not（P=0.459）. Eight patients showed a trend of improvement in the slope of daily change of dual-task cost; whereas four patients who showed little DTC at the 0 week showed less improvement. There was a significant moderately negative correlation between the dual-task cost and stroke onset days（r=-0.499，P<0.001）. (2) We have completed data analyses of 4 stroke patients who just learned to walk without cane. Comparing the results between walking with cane and walking without cane, the DTC index with cane was larger than that without cane, indicating a higher attentional demand when walking with cane. In addition, the longer the patient learned to walk without cane, the smaller the DTC index of walking without cane, relative to walking with cane.

Keywords: stroke, walk, cane, attentional demand, dual task, longitudinal follow up

前言

Successful maintenance of balance and walking function is an important component in daily life activities, and is often executed concurrently with higher level cognitive tasks. In the recent decades, numerous studies have been contributed to the understanding of attention demands of tasks of standing and walking (please see Lacour, Bernard-Demanze, & Dumitrescu, 2008;Woollacott & Shumway-Cook, 2002 for reviews). A typical paradigm in this line of research is "dual-task" in which postural control, considered the primary task, and a secondary task are performed together. The extent to which the performance on either task declines **(i.e. dual-task cost, DTC)** indicates the interference between the processes controlling the two tasks, and thus the extent to which the two tasks share attention resources.

Dual-task investigations have shown inconsistent results between positive and negative DTC, which is explained by the U-shaped nonlinear interaction model (Huxhold, Li, Schmiedek, & Lindenberger, 2006) or by the task prioritization model (Brown, Sleik, Polych, & Gage, 2002). **However, studies on patients with stroke** (Bensoussan et al., 2007; Bowen et al., 2001; Brown, Sleik, &Winder, 2002; de Haart, Geurts, Huidekoper, Fasotti, & van, 2004; Haggard, Cockburn, Cock, Fordham, & Wade, 2000; Hyndman, Ashburn, Yardley, & Stack, 2006) **or with a challenged balance task** (Huxhold et al., 2006; Riley, Baker, & Schmit, 2003; Swan, Otani, & Loubert, 2007) **have consistently reported a positive DTC, i.e. decline of performance due to dual-tasking.**

Among the challenged balance tasks, one might think of the walking task practiced by stroke survivors, which is in the process of motor learning. Stroke survivors practice very hard to achieve the goal of excellent, efficient, and safe balance and walking performance. **For the motor learning process, Fitts and Posner (1967) proposed three stages: cognitive phase, associative phase, and autonomous phase.** Therefore, as it is widely known that motor control is in need of integration among the cognitive, motor, and sensory systems, a good index of the motor learning process from the cognitive to the autonomous phase may be DTC.

However, a literature review reveals that there are only few studies utilizing DTC in motor learning in a longitudinal way- two studies in patients suffering from lower-limb amputation (Geurts & Mulder, 1994; Geurts, Mulder, Nienhuis, & Rijken, 1991) and three studies in patients with stroke (Cockburn, Haggard, Cock, & Fordham, 2003; de Haart et al., 2004; Haggard et al., 2000). Given the small number of studies in this area, even though a tendency toward reduction of DTC has been reported, the learning curve of balance automaticity could not be determined yet. Furthermore, no study has examined DTC during the learning of using walking aids, such as the rehabilitation trainings for stroke survivors who have no experience in walking with a single cane.

研究目的

The overall goal of this project is to examine the changes of attention demands associated with gait training in a longitudinal manner. **The specific aims are to:**

(1) In a cohort group of patients with stroke who just start to learn the use of a single cane for walking, to study the longitudinal changes of attention demands of cane use, by using the index of DTC.

(2) In a cohort group of patients with stroke who just learn to disuse their single cane for walking, to study the difference of DTC index between cane use and non-use.

文獻探討

Changes of DTC during rehabilitation course in patients with stroke

In the study of Haggard et al. (2000), sixteen neurologic patients who showed initial dual-task decrement were followed-up on a second occasion after a mean of 181 days. Among the three cognitive tasks, the visuospatial decision task revealed changes over time of dual-task decrement on the measure of stride duration. Even though the sample was small in size and was mixed of varying neurological etiologies, the results suggest an improvement of gait automaticity in conjunction with the task of visuospatial decision. The presence/type/change of walking aids used by the participants was, however, not mentioned.

The same research group produced another paper (Cockburn et al., 2003) by using ten patients out of the sixteen, so that only patients with stroke were reported. The initial assessment was taken during inpatient rehabilitation and the second assessment was one to nine months after. At the initial assessment, four of their participants, who were considered clinically to be at a relatively good stage of recovery, still encountered difficulties in maintaining their usual stride length when asked to attend to a cognitive stimulus. The authors documented seven out of ten patients showing reduction over time in dual-task gait decrement, whereas three out of ten showing reduction in dual-task cognitive decrement. Thus, effects were more evident in improved gait performance than in improved cognitive performance. Based on these results, the authors concluded that the extent of attention-motor interference during relearning to walk after a stroke reduced over time in the majority of patients. The presence/type/change of walking aids used by the participants was, however, not mentioned.

In the study of de Haart et al. (2004), thirty-seven patients with stroke were tested for five times during a twelve-week course of rehabilitation. While maintaining an upright standing position, participants had to respond verbally with either good or fault to varying auditory sets of single-digit additions. The longitudinal analysis revealed that the attention-motor interference on asymmetric weight distribution did not diminish over the course of rehabilitation. These results indicate that weight bearing on the paretic leg during quiet standing tends to remain under cognitive control and may not easily become spontaneous. The presence/type/change of walking aids used by the participants was, however, not mentioned.

In the study of Hyndman et al. (2009), seventy-six patients with stroke were tested at 6 and 12 months postdischarge from hospital. Postural sway was assessed in isolation and while performing a cognitive memory task. The results showed a trend of reduced sway during dual-tasking at the 12-month assessment compared with the 6-month assessment. The majority of study participants were able to walk without walking aids at both assessments.

In summary, the above-mentioned four studies have evidenced a trend of reduction of attention demands after rehabilitation of the walking task in the majority of patients with stroke. Therefore, the degree of interference between motor and other concurrent cognitive tasks appears to be a good indication of the functional state of the motor system during gait rehabilitation, especially for those whose recovery is considered relatively good clinically. Nevertheless, Haggard et al. (2000), Cockburn et al. (2003), and de Haart et al. (2004) did not mention the presence/type/change of walking aids used by their participants, and Hyndman et al. (2009) recruited a group of participants walking without walking aids. There are questions

await for future research relating to the specific balance tasks of walking with walking aids, which is a frequent situation in the population of stroke.

Lack of studies examining DTC during rehabilitation course of cane walking in patients with stroke

For the population with impaired balance, such as patients with stroke, clinicians often subscribe walking aids, such as a single cane, and design a series of training programs to maximize their walking function. A safe and effective use of walking aids requires an ability to lift and advance the device and to contact the ground in an appropriate location, in synchrony with the ongoing body movement, while avoiding inadvertent contact with the lower limbs and with animate or inanimate objects in the environment. Therefore, one would expect the above-mentioned requirements to place significant demands on CNS resources related to attention processing. **It is becoming a consensus that the use of walking aids is often associated with attention demands** (Bateni & Maki, 2005)**, i.e. lack of balance automaticity. However, no study so far looks into this area in the population of stroke.**

To our best knowledge, there have been only three studies targeting at the attention demands while using walking aids; two adopted healthy participants but not balance-impaired participants. Wright and Kemp (1992) used a dual-task paradigm to characterize the attention requirements of using a walker. They measured performance on an auditory reaction-time task, performed concurrently during ambulation, in ten healthy young adults. The results showed that reaction time was delayed to a much greater degree when using a standard pickup walker, in comparison to walking with non mobility aid or using a rolling walker. Lucki et al. (2009) compared groups of elderly people who had different levels of familiarity of walker use. The results showed that, in the group with no experience with walker use, the dual execution of walking with a walker led to longer time of the Timed Up and Go test, in comparison to the sole execution of walking without a walker. Wellmon et al. (2003) also examined attention demands while using walking aids and they were interested to compared older people who used rolling walker, single cane, or none as their walking aid. Group differences were significant in both gait and reaction time performances. The above-mentioned studies have evidenced that walking with walking aids is attention demanding, and this attention-motor interference is related to the complexity of the task and the experience of the user.

Only one study looked at changes of attention demands over time while walking with prosthesis (Geurts & Mulder, 1994; Geurts et al., 1991), in which a reduction of DTC was reported in the amputee population. Inspired by the findings on the use of prosthesis, it seems highly possible that cane-assisted walking may also, through training, associate with gradual reduction of attention-motor interference. The empty research field on the changes over time of DTC during walking with cane in the stroke population warrants future research.

研究方法

Participants

Participants were 17 patients with stroke, who first receive their cane for gait training.

The inclusion criteria were:

1. have their first-ever stroke onset on only one side of the brain.
2. able to walk on level surface with a single or quad cane but without personal help for 1+5.56+1 meters (AFO, supervision or contact guard was allowed).
3. could follow simple instructions.

The exclusion criteria were:

1. have hemi-neglect as examined by the letter cancellation test (Diller et al., 1974) and the line bisection test (Schenkenberg, Bradford, &Ajax, 1980).
2. have pusher syndrome as examined by the Scale for Contraversive Pushing (Karnath HO & Broetz D, 2003).
3. people who have prior experience with walking with walking aids.
4. people with unstable medical conditions.
5. people with other major neurologic or musculoskeletal diagnosis.

Experimental Design & Procedures

We conducted exploratory experiments using inception cohorts who were followed up for several times in the early stage soon after the inclusion criteria of independent walking was achieved.

- Collect demographic data (~10 minutes with breaks)

Upon reclusion, demographic and relevant medical data were collected. These included history of stroke, brain image findings, the Fugl-Meyer Assessment (Fugl-Meyer et al. 1975), and the Barthel index (Mahoney & Barthel, 1965) etc.

- Dual-task testing (~30 minutes with breaks)

The dual-task paradigm required participants to perform secondary cognitively demanding task while engaging in a primary motor task. Disruptions in the performance of either task were regarded as reflecting alterations in the attention requirements associated with performing the primary motor task. For the secondary cognitive task, we chose minus 1 backward courting as the cognitive task of low demand, and minus 3 backward courting as the cognitive task of high demand. As for the primary motor task, participants walked with the prescribed single cane. After one practice trial, participants were asked to walk with their single cane. They were allowed to wear their usual shoes and AFOs if applicable, but were asked to wear the same shoes and AFOs throughout the longitudinal testing. In the walkway of 5.56 meters, two extra 1 meter at each end allowed for acceleration and deceleration. Participants were asked to walk at their comfortable pace. The order of conditions was fixed in the manner: (1) single-task walking, (2) walking with cognitive task of low demand, (3) sitting with cognitive task of low demand; (4) walking with cognitive task of high demand, (5) sitting with cognitive task of high demand; and repeated with reversed sequence. By doing so, there were two trials in each condition. Participants were explained of the design prior to data collection. During all

conditions, one experimenter was always by the side of the participants to ease their insecurity and to secure their safety in case of losing balance. There were sitting rests in between conditions if needed.

- Other cognitive and physical examinations (~30 minutes with breaks)

1. The modified CTSIB test measures the sensory organization ability of static standing balance.
2. The Time Up and Go test (Podsiadlo & Richardson, 1991) measures the functional mobility status.
3. The Mini-Mental State Examination (Folstein et al. 1975) measures general mental function.
4. The Stroop Color and Word Test (Golden, 1978) and Trail Making Test (Lezak et al, 2004) measure psychomotor speed and mental flexibility.
5. Participants were also be interviewed for the date of hospital discharge, the date when they stop using cane, the therapy contents, and incidence of falls.

Apparatus

1. The GAITRite system was used to collect gait data, including gait speed, stride time variability, and symmetry between right and left gait cycles. This system could also record data of cane loading.

Data analyses

For performance of the cognitive tasks, the number of correct answers was counted. For performance of the walking task, number of near-fall events was noted down during testing. Based on software built within the GAITRite system, the following variables was extracted:

1. gait speed
2. stride time variability
3. cadence
4. Spatial and temporal asymmetry: quantified by using the ratios of step length and of single support time, respectively, between the two lower extremities.

Statistics

The effect of dual-task on performance of cognitive task and of balance task was analyzed by using the DTC formula. The Kolmogorov-Smirnov tests and log transformations, if necessary, was performed first to ensure normality of data.

Analysis of variance (ANOVA) was conducted with between-participant factor of Group (stroke vs. control) and within-participant factor of Time. Separate ANOVA tests was performed on the various variables with significance level set at .05. Patients who stop using cane for walking during follow-up and those who continue the use of cane formed different groups as the between-participant factor in separate analyses. In order to characterize the learning curve, curve fitting of the DTC index was conducted along the time frame.

結果與討論（含結論與建議）

(一) 中風病患剛學習使用枴杖的追蹤實驗

本研究共收 17 位中風患者，因轉院、流感隔離及出院因此有些患者無法繼續追蹤，每位患者完成施測的週數不同（2 人/6 次，3 人/5 次，3 人/4 次，2 人/3 次，2 人/2 次，5 人/1 次）。統計結果將只有施測一週的患者排除分析，最後剩 12 位中風患者進行分析。雙重任務成本由於有 5 次因收案時病患腳步重疊，使電子步態無法分析而改使用碼表記錄的資料。

年齡範圍 44.1-82.3 歲（平均年齡 60.４±10.8 歲），大約落在中老年的族群，身高範圍 148-179 公分（平均 162.8±10.0 公分），體重範圍 42-88 公斤（平均 66.4±13.8 公斤），性別（男性 8 人，女性 4 人），中風類型（出血性中風 7 人，缺血性中風 5 人），偏癱側（左邊偏癱 7 人，右邊偏癱 5 人），中風發生天數範圍 33-122 天（平均天數 73.1±31.0 天）處於亞急性階段，拿拐杖狀況（單腳拐 0 人，四腳拐 12 人），學拿拐天數範圍 2-68 天（平均天數 28.6±23.7），穿戴矯具 AFO 有 10 人，鞋子（10 位穿涼鞋，2 位穿布鞋），每次施測使用一樣的拐杖以及穿一樣的 AFO 及鞋子，認知能力（8 位施測迷你認知測試分數範圍 4-5 分，4 位施測簡短智能測驗分數範圍 22-29 分）無認知障礙。

患者初期（第 0 週）的狀況，福格邁爾-下肢分數範圍 14-31 分（平均分數 23.1±6.3 分），下肢控制從嚴重動作障礙到輕微動作障礙，巴氏量表分數範圍 35-90 分（平均分數 59.2±20.7 分），生活自理能力還處於中度依賴狀況，計時起走測試時間範圍 29.07-173.20 秒（平均時間 84.5±42.5 秒），此功能性移動狀態依然處於較差的狀態，坐著減 1 答對率範圍 0.20-1.75 （平均 0.8±0.4 秒），行走減 1 答對率範圍 0.15-0.88 （平均 0.4±0.2 秒），坐著減 3 答對率範圍 0.13-0.63 （平均 0.3±0.2 秒),行走減 3 答對率範圍 0.03-0.37（平均 0.2±0.1 秒),行走速度之雙重任務成本範圍-1.49-34.45%（平均 18.2±11.0），只有一位是負值，表示說大多數的患者在亞急性期剛拿拐杖執行雙重任務時，還不能夠有效的分配並且同時去執行任務，因此會使的執行任務時成效降低，所花費的成本提高。

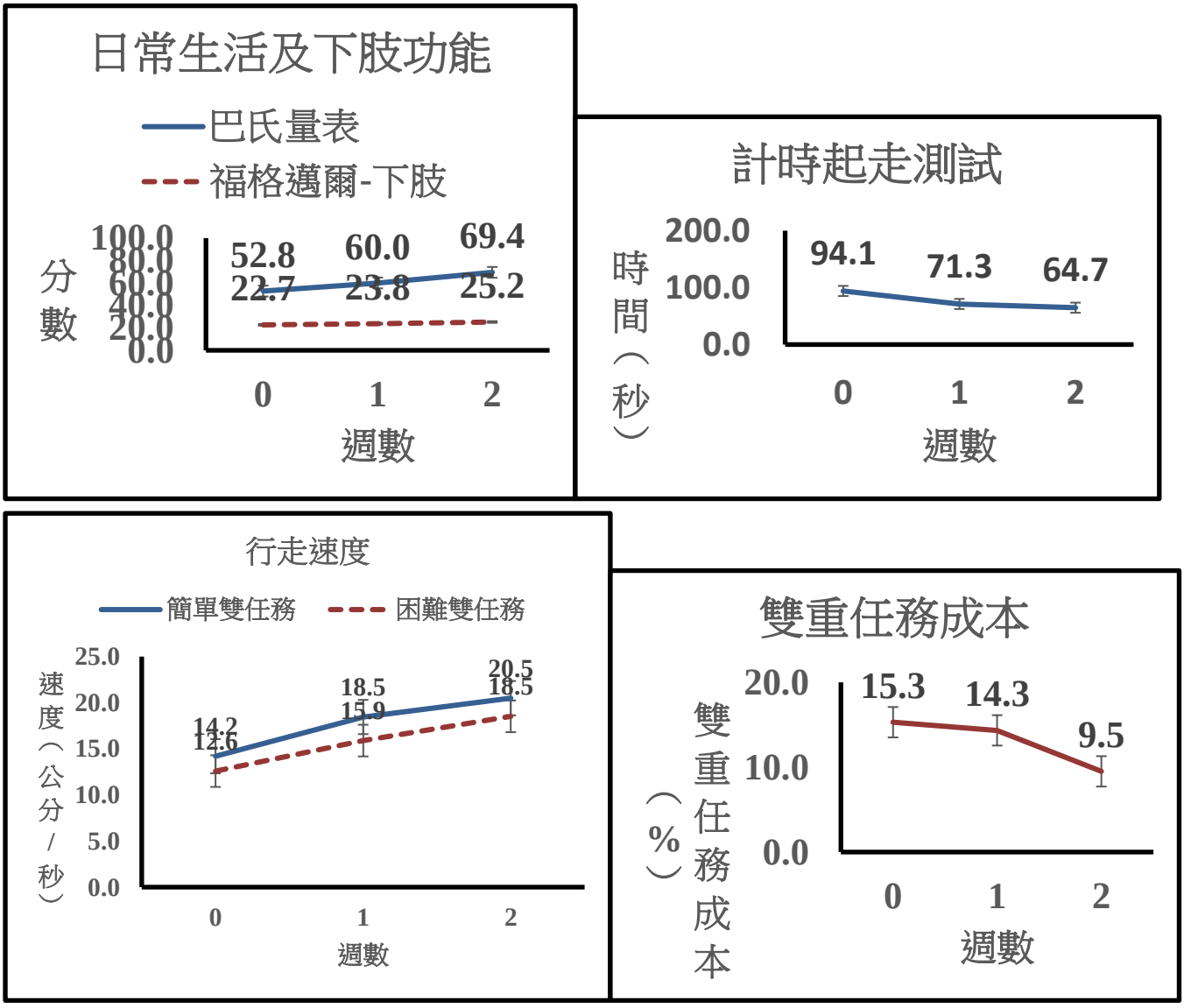
	個數 平均值 ± 標準差	最小值	最大值
性別（男/女）	8/4		
年齡（歲）	60.4 ± 10.8	44.1	82.3
身高（公分）	162.8 ± 10.0	148	179
體重（公斤）	66.4 ± 13.8	42	88
中風診斷（出血性/缺血性）	7/5		
偏癱測（左邊/右邊）	7/5		
中風發生天數	73.1 ± 31.0	33	122
學拿拐天數	28.6 ± 23.7	2	68
拿拐狀況（單腳拐/四腳拐）	0/12		
穿戴 AFO（人）	10		
福格邁爾-下肢/（34 分）	23.1 ± 6.3	14	31
巴氏量表/（100 分）	59.2 ± 20.7	35	90
計時起走測試（秒）	84.5 ± 42.5	29.07	173.20
簡單雙重任務行走速度(公分/秒）	15.4 ± 9.7	5.10	38.90
困難雙重任務行走速度(公分/秒）	13.0 ± 9.3	3.80	36.60
雙重任務成本（%）	18.2 ± 11.0	-1.49	34.45
坐著減 1（次數/秒）	0.8 ± 0.4	0.20	1.75
行走減 1（次數/秒）	0.4 ± 0.2	0.15	0.88
坐著減 3（次數/秒）	0.3 ± 0.2	0.13	0.63
行走減 3（次數/秒）	0.2 ± 0.1	0.03	0.37

使用 Kolmogorov-Smirnov 來分析每個變項第 0 週是否為常態分佈。結果顯示中風發生天數、學拿拐天數、福格邁爾-下肢分數、計時起走測試時間、簡單及困難雙重任務平均行走速度為常態分佈。巴氏量表分數背離常態分佈單峰高度右偏，代表患者於第 0 週生活自理能力是較差的，大多需要仰賴他人協助、雙重任務成本背離常態分佈單峰高度左偏，代表患者於第 0 週大多數的患者處於正值，大多數的患者在執行雙重任務的時候還不能有效的分配並且同時去執行任務，因此會使的執行任務時成效降低，所花費的注意力成本提高。由於每位患者完成週數不同，有 2 位患者只完成兩週，另 1 位患者雖完成四次，但第二週因流感隔離，因此在此分析排除。

使用一般線性模型（general linear model）的重複測量（Repeated-Measures Designs）變異數分析（Analysis of Variance）來分析，由於每位患者完成週數不同，有 2 位患者只完成兩週，另 1 位患者雖完成四次，但第二週因流感隔離，因此在此分析排除，最後取 9 位中風患者的前三週（0、1、

2 週）分析。結果顯示隨著時間福格邁爾-下肢分數（$F_{2,16}$=12.37, P=0.001）、計時起走測試時間（$F_{2,16}$=5.53,P =0.015）、簡單雙重任務行走速度（$F_{2,16}$=5.87, P=0.012）、困難雙重任務行走速度（$F_{2,16}$=7.95, P=0.004）皆顯著進步（表二）。且呈現性趨勢，福格邁爾-下肢分數呈線性（$F_{1,8}$=17.93, P=0.003）、計時起走測試時間呈線性（$F_{1,8}$=10.35, P=0.012）、簡單雙重任務行走速度呈線性（$F_{1,8}$=6.71, P=0.032）、困難雙重任務行走速度呈線性（$F_{1,8}$=9.59, P=0.015）。由於巴氏量表無常態分佈，因此使用 Friedman Test 來分析 9 位中風患者前三週時的改變是否顯著，結果顯示巴氏量表（P=0.001）顯著進步。

探討追蹤中風患者前三週拿拐杖學習行走的雙重任務成本的變化。由於雙重任務成本無常態分佈因此使用 Friedman Test 來分析，因每位患者完成週數不同，有 2 位患者只完成兩週，1 位患者雖完成四次，但第二週因流感隔離，因此在此分析排除，最後取 9 位中風患者的前三週（0、1、2 週）分析。雖然從統計線圖來看，雙重任務成本是呈現下降趨勢，但是統計結果顯示雙重任務成本（P=0.459）無顯著進步。



施測項目	第 0 週	第 1 週	第 2 週	
	平均值 ± 標準差			顯著性
福格邁爾-下肢	22.7 ± 5.8	23.8 ± 5.9	25.2 ± 6.4	0.001*
計時起走測試	94.1 ± 43.5	71.3 ± 48.8	64.7 ± 29.1	0.015*
巴氏量表	52.8 ± 17.3	60.0 ± 19.4	69.4 ± 16.7	0.001*
簡單雙重任務行走速度	14.2 ± 10.6	18.5 ± 13.6	20.5 ± 16.3	0.012*
困難雙重任務行走速度	12.6 ± 10.5	15.9 ± 12.5	18.5 ± 15.1	0.004*
雙重任務成本	15.3 ± 10.8	14.3 ± 8.1	9.5 ± 12.3	0.459

* $P<0.05$

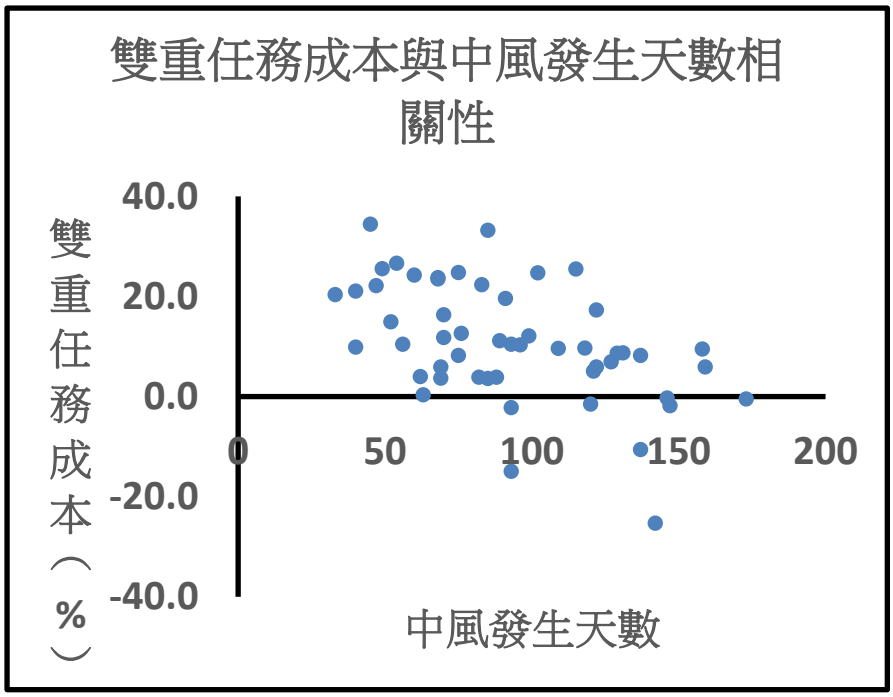
進一步分析 12 位中風患者從第 0 週到最後一週實際施測雙重任務成本的斜率，若為（+）值代表執行任務時所需要花費的注意力成本是隨著時間變多，表示能力變差或者沒有進步；若為（-）值代表執行任務時所需要花費的成本是變少表示能力變好（單位：雙重任務成本/時間）。結果顯示有 9 位中風患者的雙重任務成本的斜率有進步的趨勢，只有 4 位患者很輕微持平沒有進步的狀態(-0.01%、0.01%、0.15%、0.01%），從數據來看這樣的變化很微小的退步，而這 4 位患者都是雙重任務成本基線較小，斜率範圍 0.15~-2.46。代表著大部分的中風患者隨著時間的恢復或治療，能力越來越進步，越能夠在執行雙重任務時有效的分配並同時執行任務，使的執行任務成效提高。

受試者編號	1	2	3	4	5	6	7	8	9	10	11	12
第 0 週雙重任務成本（%）	26.61	23.75	34.45	25.49	23.50	20.37	-1.49	9.88	5.91	3.69	22.35	24.25
最後一週雙重任務成本（%）	-0.32	5.05	24.72	-0.50	12.10	9.66	-1.87	10.31	8.19	3.87	-2.22	16.30
天數差值（單位：天數）	92	53	57	58	31	85	27	56	15	19	10	10
斜率變化	-0.29	-0.35	-0.17	-0.45	-0.37	-0.13	-0.01	0.01	0.15	0.01	-2.46	-0.79

$$\text{斜率：}\frac{\text{最後一週雙重任務成本}-\text{第 0 週雙重任務成本}}{\text{最後一週天數}-\text{第 0 週天數}}$$

探討患者隨著時間每一次施測的雙重任務成本與其他變項之間的相關性，於雙重任務成本由於有 5 次因收案時病患腳步重疊，使電子步態無法分析而改使用碼表記錄的資料，另外 3 次數據於雙重任務成本為離群值，所以在此分析排除。使用斯皮爾曼等級相關係數（Spearman's rank correlation coefficient)分析，結果顯示雙重任務成本與中風發生天數呈現顯著中度負相關($r=-0.499$, $P<0.001$），

代表著隨著時間的恢復及治療，病人越能夠在執行雙重任務時有效的分配並同時執行，使的執行任務成效提高。雙重任務成本與學拿拐天數(r=-0.104, P=0.479)、福格邁爾-下肢(r=-0.165, P=0.256)、計時起走測試(r=0.067, P=0.648)、巴氏量表(r=-0.141, P=0.332)、簡單雙重任務行走速度(r=0.025, P=0.864)、困難雙重任務行走速度(r=-0.178, P=0.221)皆無顯著相關性。



變項	雙重任務成本	
	r 值	P 值
年齡	0.049	0.738
福格邁爾-下肢	-0.165	0.256
計時起走測試	0.067	0.648
巴氏量表	-0.141	0.332
簡單雙重任務行走速度	0.025	0.864
困難雙重任務行走速度	-0.178	0.221
中風發生天數	-0.499	0.0001*

r=1 完全相關；0.7-0.9 高度相關；0.4-0.69 中度相關；0.39 以下低度相關

* P<0.05

(二) 比較剛放拐杖行走之中風病患拿拐杖與不拿拐杖

目前已經完成四位剛學會不拿拐杖行走之中風病患資料分析。我們測試了其拿拐杖與不拿拐杖行走的雙任務測試，結果整理如下表。在各項行走參數的雙重任務虧損指標上，拿拐杖普遍比不拿拐杖大，表示拿枴杖行走有較高的注意力需求，受到減數任務的影響較大。在減數表現的雙重任務虧損指標上，拿拐杖普遍比不拿拐杖小，表示這些病患在拿改杖行走時將較多注意力資源給了減數

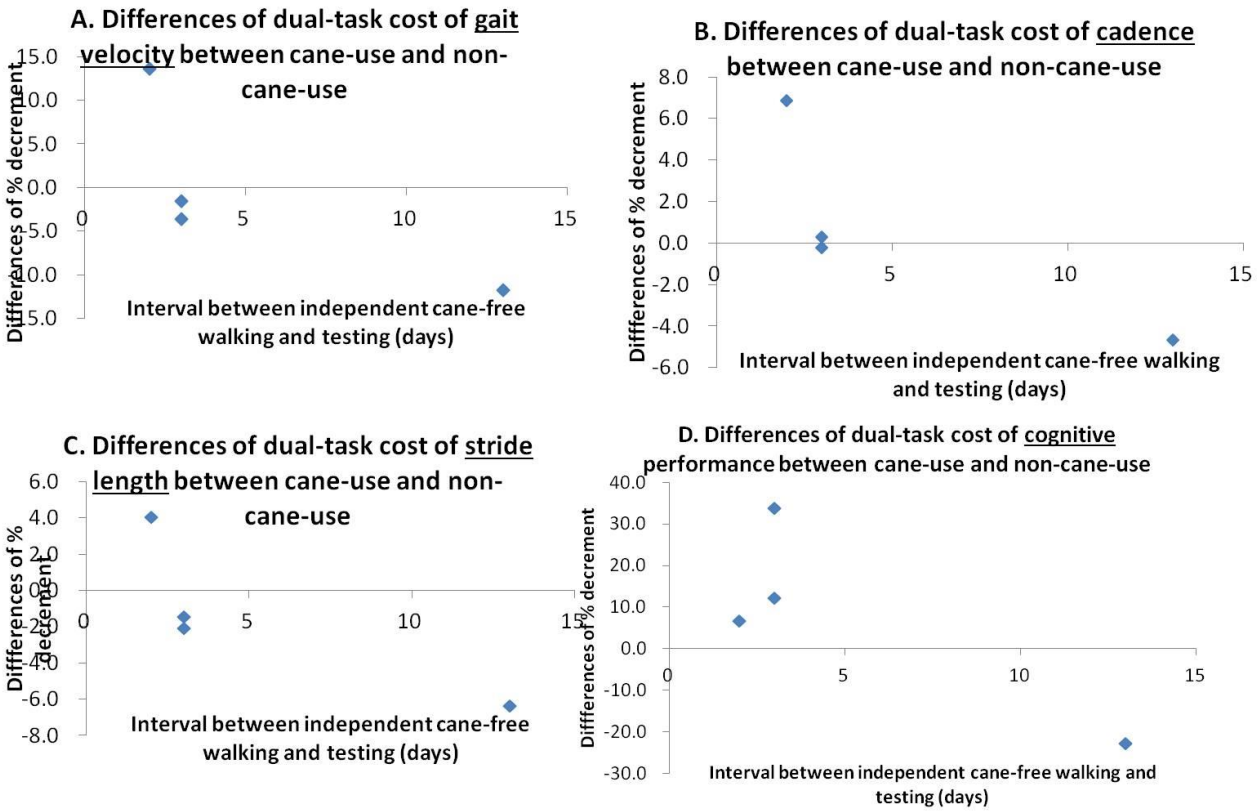
任務，而在不拿改杖行走時將較多注意力資源給了行走任務。

Individual performance on tests comparing cane-use and non-cane-use

	Patient number	Interval between independent cane-free walking and testing comparing cane-use and non-cane-use (days)	Velocity (cm/s)				Cadence (steps/min)				Stride length (cm)				Percentage of correct answers (%)			
			Cane-use	% decrement	Non-cane-use	% decrement	Cane-use	% decrement	Non-cane-use	% decrement	Cane-use	% decrement	Non-cane-use	% decrement	Cane-use	% decrement	Non-cane-use	% decrement
lower-demand arithmetic task[1]	1	3	51.1		59.0		72.2		82.3		85.1		85.7		90.9		87.5	
	2	3	29.8		37.5		58.8		71.0		60.8		63.8		87.5		85.7	
	3	2	18.4		15.0		32.2		31.6		69.3		57.5		93.8		100.0	
	4	13	27.3		31.7		61.1		73.9		53.5		51.7		90.0		100.0	
higher-demand arithmetic task[2]	1	3	46.7	8.71	54.8	7.12	70.4	2.49	80.4	2.31	80.0	6.00	82.3	3.93	100.0	-10.00	66.7	23.81
	2	3	28.6	3.87	37.4	0.27	60.3	-2.55	72.6	-2.25	58.0	4.63	61.7	3.19	100.0	-14.29	87.5	-2.08
	3	2	18.4	-0.27	13.0	13.33	30.4	5.44	27.7	12.34	71.9	-3.65	57.3	0.40	100.0	-6.67	100.0	0.00
	4	13	22.9	16.30	30.3	4.57	54.5	10.88	69.3	6.23	51.1	4.54	52.6	-1.82	54.5	39.39	83.3	16.67

1: lower-demand arithmetic task is serial subtractions by ones
2: higher-demand arithmetic task is serial subtractions by threes

下圖繪製了各項雙重任務虧損指標與學會放拐杖行走天數的相關圖，縱軸為拿拐杖與不拿拐杖的雙重任務虧損指標差異值，橫軸為學會放拐杖行走的天數。雖然受試者只有四位，但負相關的趨勢已經接近統計顯著(P=0.051)，顯示放拐杖的天數愈久，受試者越習慣放拐杖行走，不拿拐杖的雙重任務虧損(相較於拿拐杖行走)愈小。



(三) 結論與未來工作

中風患者經過一段時間的恢復與治療，下肢動作控制、行走能力及日常生活功能能力是持續進步，雙重任務成本雖然於統計上沒有顯著進步，但是從統計圖來看是呈現下降趨勢，而以方式斜率來看，每位患者的第 0 週到實際施測最後一次，也能夠看到進步的趨勢，這些都可以表示中風患者隨著時間，同時執行行走及認知任務的能力持續進步。最後我們也發現雙重任務成本與中風發生天數呈現中度負相關，表示著患者於雙重任務成本進步與中風發生天數是有關連，對應著前面提到隨著時間恢復與復健，下肢動作控、行走能力及日常生活能力的進步將可能會使的中風患者可以越來越有效率的分配並且同時執行任務。

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本人於2017年6月8-11日出席於神戶舉辦之「IAFOR2017 : The Asian Conference on Aging & Gerontology 2017」，茲簡述此研討會如下。

1. 此研討會的參與者來自經濟學、社會學、健康照護等領域，研討會主題為東方社會面對各代各個面向的現況，對老人和其家庭造成的影響。
2. 我出席了專題演講「Methodologies for the Collection of Comparative Community Level Public Health Data: Obtaining Powerful and Statistically Meaningful Findings for Small Populations」、「Using Mindfulness Practices to Improve Mental Health and Address Unconscious Bias」，受到跨領域的刺激，更全面性的看到老人和其支持系統面臨的挑戰。
3. 我發表論文「Aerobic training effects on physical abilities and cognitive functions in community-dwelling elders.」，與來自各地學者有很好的討論，刺激本人在投稿寫作上的想法，後續成功發表於期刊(Tang YW, Chu YH, Chen HI, *Chen HY. Practical experiences of multicomponent exercise for community-dwelling prefail/frail elderly people. Chung Shan Medical Journal: in press.)。

104年度專題研究計畫成果彙整表

計畫主持人：陳惠雅			**計畫編號：**104-2410-H-040-001-MY2		
計畫名稱：行走任務學習過程中雙重作業虧損之變化：中風病患使用單腳拐者之長期研究					
成果項目			量化	單位	質化 （說明：各成果項目請附佐證資料或細項說明，如期刊名稱、年份、卷期、起訖頁數、證號...等）
國內	學術性論文	期刊論文	1	篇	Tang YW, Chu YH, Chen HI, *Chen HY. Practical experiences of multicomponent exercise for community-dwelling prefail/frail elderly people. Chung Shan Medical Journal: in press.
		研討會論文	0		
		專書	0	本	
		專書論文	0	章	
		技術報告	0	篇	
		其他	0	篇	
國外	學術性論文	期刊論文	2	篇	1.Tang PF, Yang HJ, Peng YC, *Chen HY. Motor dual-task "Timed Up & Go" better identifies prefrailty individuals than single-task "Timed Up & Go". Geriatrics & Gerontology International 2015 15(2):204-210. 2.Chen HY, *Tang PF. Factors contributing to single- and dual-task Timed “Up & Go” test performance in middle-Aged and older adults who are active and dwell in the community. Physical Therapy 2016: Mar;96(3):284-92.
		研討會論文	3		1.Tang PF, *Chen HY. (2014 Aug 27-29) Different Determinants for Single- and Dual-Task Timed Up & Go Performance. The Inaugural Asian Conference on the Life Sciences and Sustainability. Hiroshima, Japan. 2.*Chen HY. (2014 Aug 27-29) Validity and Reliability of Single- and Dual-Tasking Timed Up & Go Tests. The Inaugural Asian Conference on the Life Sciences and Sustainability. Hiroshima, Japan. 3. *Chen HY, Tang YW, Chen HI, Chu YH. (2017Jun 8-11) Aerobic training effects on physical abilities and cognitive functions in community-dwelling elders. The Asian

					Conference on Aging & Gerontology 2017. Japan, Kobe.
		專書	0	本	
		專書論文	0	章	
		技術報告	0	篇	
		其他	0	篇	
參與計畫人力	本國籍	大專生	1	人次	謝雅雯
		碩士生	1		曹涵婷
		博士生	0		
		博士級研究人員	0		
		專任人員	1		曹涵婷
	非本國籍	大專生	0		
		碩士生	0		
		博士生	0		
		博士級研究人員	0		
		專任人員	0		
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。）					