



Original Article

Cognitive-motor interference in post-stroke individuals and healthy adults under different cognitive load and task prioritization conditions

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Abstract. [Purpose] We aimed to compare the effects of cognitive load and task prioritization on dual task strategies in patients with stroke and healthy adults in order to clarify the characteristics of cognitive-motor interference. [Participants and Methods] In total, 26 patients with stroke and 26 age-matched healthy adults (controls) performed the Timed Up and Go Test while performing a serial subtraction task from random numbers between 90 and 100. Dual task was measured under four conditions in which two difficulty levels of “3 subtraction” and “7 subtraction” were multiplied by two prioritizing tasks that involved “paying equal attention to both walking and subtraction tasks” (no priority) and “paying attention while mainly focusing on subtraction tasks” (cognitive priority). [Results] Increasing cognitive load and prioritizing cognitive tasks affected motor performance in terms of the amount of time and number of steps required to complete the Timed Up and Go Test in both the patients and controls. However, cognitive load and task prioritization did not affect cognitive performance. [Conclusion] When cognitive load increases and instructions are given to prioritize increases in cognitive load, patients with stroke use the “posture first” strategy to stabilize their gait as effectively as healthy adults do.

Key words: Dual task, Stroke patients, Cognitive-motor interference

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INTRODUCTION

Walking is usually an automatic movement that requires little attention. However, healthy young persons also require some attention resources^{1, 2}), as do elderly persons and patients with neurological disorders³), and adding concurrent cognitive tasks further increases the demand for attention resources⁴). Walking under normal circumstances can be considered not only as a single task (ST) but also as a complex task, such as simultaneously walking while talking. Thus, there is a dual task paradigm⁵) for evaluating interactions between cognition and motor performance. Dual task (DT) is the simultaneous execution of two required tasks that are simultaneously implemented while appropriately allocating attention to both⁶). Cognitive-motor interference (CMI) occurs under such circumstances; the information processing capability for both tasks is lowered, and the performance of one or both tasks will decrease⁷). Allocating attention appropriately to the two tasks is important for activities of daily living (ADL), because inappropriate attention to concurrent tasks can result in falls. Lundin-Olsson et al.⁸) suggested that elderly persons who stopped walking while talking are at high risk for falls, and a systematic review of factors associated with falls and DT found that DT can be a predictive measure of falls among elderly persons^{9, 10}). Furthermore, Mendel et al.¹¹) suggested that dual task training as a treatment strategy for neurological rehabilitation improves gait, cognition, automation skills and transference of learning and may be a valuable strategy for neurological physical therapy. However, it is also described that additional investigation with better methodological rigor is necessary for accurately assessment of the effects

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of that strategy on the neurological population.

Cognitive-motor interference that has been identified in younger persons, increases with aging¹²⁾ and after a stroke¹³⁾, when it influences ambulation¹⁴⁾. Increased in CMI in patients with stroke might be due to decreased motor function, cognitive function or walking ability. Habitual walking requires the appropriate allocate of attention to additional information such as turning direction, avoiding obstacles and talking. Stroke patients need to appropriately allocate attention to walking and additional information to walk safely within their communities, because inappropriate prioritization can result in falls¹⁵⁾.

Thus, strategies are used to prioritize which of two tasks is more important when applying DT to predict falls and to determine intervention to prevent falls. Elderly persons use the posture first strategy that gives priority to walking stability¹⁶⁾, whereas patients with Parkinson's disease use a posture second strategy, which cannot prioritize stability while walking¹⁷⁻¹⁹⁾. In addition, these strategies are affected by the nature²⁰⁾ and the difficulty²¹⁾ of a secondary task, even when given instructions about which of two tasks to prioritize¹⁹⁾.

However, few studies have investigated the effects of simultaneously cognitive load and task prioritization. Maclean et al.²²⁾ reported that healthy elderly people reduce walking speed as cognitive load increases and concentrate on the cognitive task. Furthermore, although patients with stroke reportedly to use the posture first strategy on DT²³⁾, the effects of cognitive load and task prioritization on stroke patients remain unknown. The present study aimed to examine the effect of cognitive load and instructions regarding task prioritization on the performance of DT by patients with stroke and healthy adults.

PARTICIPANTS AND METHODS

This cross-sectional study analyzed the effects of cognitive load and task prioritization instruction as independent variables. Low and high cognitive loads comprised counting backwards in sets of 3 (Serial 3s) and in sets of 7 (Serial 7s), respectively. The prioritization instructions comprised no (NP) and cognitive (CP) priority. The dependent variables comprised dual task cost (DTC) (described later) for gait performance as measured by elapsed time and number of steps, and for cognitive performance measured as number of correct cognitive responses per second.

Twenty-six patients with stroke and 26 age-matched healthy adult controls were recruited. The patients were recruited from the convalescence rehabilitation ward and geriatric health services facility of the General Foundation Harunaso and identified from descriptions in their medical charts. The inclusion criteria comprised able to walk alone or with or without walking aid; able to count backwards insets of 3 while seated (more than three continuous answers were possible) and sufficient exercise tolerance determined from assessments. Exclusion criteria comprised withheld consent to participate, difficulties with verbal responses and understanding questions or instructions due to dementia, aphasia or dysarthria and other cognitive disturbances, requires >5 minutes for the Trail Making Test A (described later), at confirmed high risk of falls, and neurological diseases such as Parkinson disease and traumatic brain injury or severe orthopedic diseases such as osteoarthritis and rheumatoid arthritis that affect walking ability. Healthy adults were recruited from the local community. They fulfilled the same inclusion and exclusion criteria as the patients with stroke except for the self-reported absence of stroke.

The research ethics committee at Harunaso Hospital approved (approval number: 130103) the study and all participants provided prior written informed consent, in accordance with the Declaration of Helsinki (2008).

We measured the cognitive function of the patients using the Trail Making Test (A and B)²⁴⁾, stroke severity using Fugl-Meyer lower extremity assessment (FMLE)²⁵⁾ and functional gait ability using Functional Ambulation Categories (FAC)²⁶⁾. The FMLE is a measure of motor recovery following a stroke that includes a lower extremity subscale of 17 items, with each item scored on a scale of 0–2 (score range, 0–34). The FAC is a functional walking test that evaluates ambulation ability and classifies patients into six categories (range, 0–5).

Thereafter, the participants executed one Timed Up & Go (TUG) trial, two cognitive trials, and four DT trials. All TUG trials (ST and DT) proceeded on a level surface in a well-lit, obstacle-free environment. Participants performed the two cognitive trials (Serial 3s and 7s) and ST trial followed by the DT trials under randomized conditions in that order.

Under the single cognitive conditions, participants were seated on a standard chair and recorded counting backwards, subtracting either 3s (Serial 3s) or 7s (Serial 7s) from any given number between 90 and 100 for 30 seconds. Under the single TUG conditions, participants executed the TUG test without a cognitive task. A standard chair was used, and a cone was placed at the 3-meter mark on a path walked from the chair. Participants sat on the chair. The investigator provided the following instructions: "When I say 'Go', please stand up from the chair and walk at a comfortable speed to the cone; turn 180° around the cone, walk back, and sit down on the chair." The DT conditions comprised simultaneously executing the TUG test and counting backwards (Serial 3s and 7s). At the start of each DT the participants walked and counted backwards in either 3s or 7s, and were instructed to concentrate equally on both tasks (no priority: NP) or more on the cognitive task than walking (cognitive priority: CP). The investigator verbally informed seated participants of a number between 90 and 100 and then said, "Go". The participants then started the TUG test and consecutively counted backwards by 3 or 7 from the number and simultaneously gave verbal responses. The start number between 90 and 100 for each ST and DT trial was randomly chosen. Each ST and DT cognitive task started with a different number, never with the same two digits. No specific instructions were provided regarding mistakes occurring in the DT or hesitation while walking under DT conditions. All DT conditions were video-recorded using a Sony camera (HDR-CX500V) and an Olympus Voice recorder (Voice-Trek V-801). Participants practiced one or two trials before implementing the actual trial. We calculated DTC (%) for each condition as $100 \times (DT-ST)/ST$.

Table 1. Characteristics of patients and healthy individuals

Measured parameters	Healthy adults (N=26) Means \pm SD (range)	Stroke patients (N=26) Means \pm SD (range)
Background		
Age (yrs)	69.2 \pm 12.3 (43–86)	69.2 \pm 12.0 (44–88)
Gender (male:female)	8:18	18:8
Stroke and motor status		
Poststroke duration (month)		69.9 \pm 63.7 (2.9–203.8)
Fugl-Meyer lower extremity assessment		25.8 \pm 4.8 (17–34)
Timed Up & Go (s)	9.1 \pm 1.5 (6.5–11.9)	17.6 \pm 7.6* (8.0–37.7)
Functional Ambulation Categories		5=20, 4=6
Cognitive status		
Trail Making Test part A (s)		69.0 \pm 41.6 (29.9–238.3)
Trail Making Test part B (s)		164.3 \pm 93.4 (41.1–466.5)
Delta TMT (TMT B - TMT A) (s)		95.3 \pm 73.4 (5.9–369.5)
Serial 3s (correct responses/s while seated)	0.44 \pm 0.18 (0.17–0.83)	0.33 \pm 0.15* (0.10–0.80)
Serial 7s (correct responses/s while seated)	0.25 \pm 0.16 (0.07–0.66)	0.17 \pm 0.12 (0.03–0.65)

*p<0.05 compared to the healthy adults.

The effects of the dual task on gait and cognitive measures between groups were compared using 2×2 repeated measures analyses of variance (ANOVA). Dual task costs were analyzed using a 2 (group) $\times 2$ (cognitive load) $\times 2$ (task prioritization) mixed model ANOVA to determine the main effects and interactions among group, cognitive load and task prioritization. The significance for all analyses was set at 0.05. All data were analyzed using SPSS version 24.0 for Windows.

RESULTS

Table 1 summarizes the characteristics of the participants. Both groups were similar with respect to age. Predictably, stroke patients required significantly more time to complete the Timed up and Go test, and had significantly fewer correct responses per second in serial 3s. All the patients completed the TMT-A within 5 minutes which, if accompanied by an MMSE score of ≥ 24 points²⁷⁾, reportedly indicates good cognitive health. Stroke patients had a long post-stroke duration, and motor function disorder and cognitive dysfunction were relatively mild.

Table 2 shows the results of the ST and DT (means \pm standard deviation [SD]) under the four conditions and the effects of the dual task (ST vs. DT). Interactions in all measures were not significant under the group \times dual task effects. The main effects of TUG time and number of steps were significant under all four and three (serial 3s CP, serial 7s NP and serial 7s CP) DT conditions, respectively. The main effect of the number of correct responses per second was significant under serial 7s two DT conditions (serial 7s NP, serial 7s CP).

The results of the mixed model 3-way ANOVA showed that group \times cognitive load \times task priority interaction was not significant for the DTC of TUG time and number of steps, but was significant for the number of correct responses per second ($p < 0.05$; Table 3). In addition, the group \times task priority and group \times cognitive load interaction was not significant. We identified significant main effects of task prioritization for DTC of TUG time and number of steps (both $p < 0.01$). We also found a significant main effect of cognitive load for DTC of TUG time and number of steps (both $p < 0.01$). However, the main effect of cognitive load and task prioritization for DTC on the number of correct responses per second was not significant.

DISCUSSION

The ability to execute motor and cognitive tasks was lower in the patients than the healthy adults. The effects of the dual task on both motor and cognitive performances were significant, especially under conditions of serial 7s and CP. This indicates that CMI occurs in patients with stroke as well as healthy adults.

Furthermore, effects of cognitive load and task prioritization on DT were similar for both patients and healthy adults. Healthy elderly people reportedly reduce walking speed as cognitive load increases and they concentrate on a cognitive task²²⁾. The present findings of patients with stroke were similar to these. As cognitive load increased, attentional resources were allocated to the cognitive tasks, which increased the amount of time and number of steps required to complete the TUG. When instructed to concentrate on cognitive tasks, the amount of time and the number of steps required to complete the TUG increased as compensation for concentrating on cognitive tasks. This finding indicates that patients with stroke, as with healthy adults, use the strategy prioritizing walking stability when cognitive load increases or when instructed to prioritize cognitive tasks in concurrent tasks. That is, patients with stroke are as flexible with respect to attention allocation to concurrent tasks as age-matched healthy controls, at least with respect to motor performance. However, a similar study of young healthy adults²⁸⁾ found a significant difference only in the prioritizing instruction (not the cognitive load), for which they had high cognitive function and sufficient postural reserves to allocate resources to the cognitive task. Therefore, they

Table 2. Performance outcome measures under single and dual-task conditions

	Single task		Dual task	
	Motor task	Cognitive task	No priority	Cognitive priority
Cognitive load: serial 3s				
Time to complete Timed Up & Go (s)				
Healthy adults	9.1 ± 1.5		11.0 ± 3.2	11.0 ± 3.0
Stroke patients	17.6 ± 7.6		20.8 ± 10.0*§	21.6 ± 10.7*§
Number of steps to complete Timed Up & Go				
Healthy adults	15.3 ± 2.5		17.4 ± 5.1	17.4 ± 4.8
Stroke patients	24.5 ± 8.4		27.9 ± 10.3§	28.7 ± 10.9*§
Number of correct responses per second				
Healthy adults		0.44 ± 0.18	0.42 ± 0.23	0.43 ± 0.19
Stroke patients		0.33 ± 0.15	0.30 ± 0.20‡	0.27 ± 0.18§
Cognitive load: serial 7s				
Time to complete Timed Up & Go (s)				
Healthy adults	9.1 ± 1.5*		11.0 ± 2.8	12.0 ± 4.6
Stroke patients	17.6 ± 7.6*		22.7 ± 11.2*§	23.7 ± 12.5†§
Number of steps to complete Timed Up & Go				
Healthy adults	15.3 ± 2.5*		17.5 ± 5.1	18.2 ± 5.3
Stroke patients	24.5 ± 8.4*		29.5 ± 11.2*§	30.0 ± 11.5†§
Number of correct responses per second				
Healthy adults		0.25 ± 0.16	0.29 ± 0.17	0.23 ± 0.18
Stroke patients		0.17 ± 0.12	0.15 ± 0.11†§	0.15 ± 0.11†§

Values are shown as means ± standard deviation.

Significant main effects at *p<0.05 and †p<0.01.

Significant between-group effects at ‡p<0.05 and §p<0.01.

Table 3. Dual task costs: results of 3-way (2 × 2 × 2) mixed ANOVA comparison of cognitive load and task prioritization between healthy adults and patients with stroke

	Cognitive load	No priority	Cognitive priority
Time to complete Timed Up & Go†§			
Healthy adults	Serial 3s	20.0 ± 21.7	20.3 ± 19.5
	Serial 7s	21.2 ± 19.0	30.4 ± 34.6
Stroke patients	Serial 3s	16.8 ± 20.6	21.8 ± 24.8
	Serial 7s	29.0 ± 32.0	34.7 ± 43.8
Number of steps to complete Timed Up & Go†§			
Healthy adults	Serial 3s	13.2 ± 16.7	13.9 ± 17.4
	Serial 7s	14.2 ± 17.7	18.9 ± 19.6
Stroke patients	Serial 3s	13.5 ± 11.8	16.5 ± 13.5
	Serial 7s	19.9 ± 16.2	21.9 ± 16.2
Number of correct responses per second ^l			
Healthy adults	Serial 3s	-3.6 ± 34.0	2.5 ± 33.9
	Serial 7s	33.7 ± 66.8	2.4 ± 65.4
Stroke patients	Serial 3s	-10.0 ± 35.2	-15.6 ± 40.9
	Serial 7s	0.7 ± 75.0	10.2 ± 120.2

Values are shown as means ± standard deviation.

Significant main effects (task prioritization) at *p<0.05 and †p<0.01.

Significant main effects (cognitive load) at ‡p<0.05 and §p<0.01.

Significant interaction (group × task prioritization × cognitive load) at lp<0.05.

were not affected by cognitive load, which is different from the healthy adults and patients in the present study.

With respect to cognitive task, we found no effects of cognitive load and prioritizing instructions in the controls and patients. These findings suggest that as attentional demands increase, patients and healthy adults respond by reducing walking speed and the number of steps to prioritize completion of the cognitive task, and the cost of cognitive resources does not necessarily depend on the increase of attentional demand in concurrent tasks. This indicates that stroke survivors, like healthy adults, can perform concurrent tasks as long as risk of falling is no significant. However, one study of healthy adults²²⁾ found that the performance of cognitive tasks declined with increasing cognitive load. Our findings differed from these, perhaps due to the shorter distance walked to influence the cognitive task in the present study.

If CMI increases after stroke, walking performance during concurrent tasks declined. Cognitive-motor interference might contribute to the risk of falling among patients with stroke if they inappropriately prioritize tasks¹⁵⁾. For example, if they

assign priority to a conversation while maintaining walking speed they might stumble over obstacles. One report describes that patients with stroke use the posture first strategy in concurrent tasks to stabilize walking²³). The present results were the same. That is, if cognitive load increases or prioritizing a cognitive task is instructed, patients might select an appropriate strategy to prioritize the walking stability. Several studies have described that CMI decreases over time during recovery from stroke, and dual task performance improves after stroke^{29, 30}). Furthermore, dual task gait performance improves after dual task training in patients with stroke^{31, 32}). Many of the present patients were in the chronic phase of stroke and had been adapted to everyday dual tasks, indicating that use the most appropriate strategy for concurrent tasks like healthy adults.

This study has several limitations. Since the patients had relatively mild dysfunction and gait disturbance, the characteristics of CMI compared to healthy adults might have been harder to appear. To identify the characteristics of stroke might require studying stroke survivors with more severe dysfunction and gait disturbances. We measured only the amount of time and the number of steps require to complete the TUG test as an outcome of motor ability. To better identify the strategy applied to concurrent tasks, other aspects of gait might need to be measured. The distance walked might be too short to further clarify a cognitive task strategy. Since the degree of CMI and the task prioritization strategy are specific to combinations of the motor and cognitive tasks, walking distance should be considered with respect to the type and difficulty of the cognitive task.

In conclusion, this study compared the effects of cognitive load and task prioritization on walking and counting DT on patients with stroke and healthy adults. Increasing cognitive load and prioritizing the cognitive task similarly affected motor performances in the patients and healthy adults. When cognitive load increases and instructions are provided about prioritizing, patients with stroke use a posture first strategy to stabilize walking.

Conflict of interest

The authors have no conflicts of interest that are directly relevant to the content of this article.

REFERENCES

- 1) Beauchet O, Dubost V, Herrmann FR, et al.: Stride-to-stride variability while backward counting among healthy young adults. *J Neuroeng Rehabil*, 2005, 2: 26. [Medline] [CrossRef]
- 2) Regnaud JP, Roberston J, Smail DB, et al.: Human treadmill walking needs attention. *J Neuroeng Rehabil*, 2006, 3: 19. [Medline] [CrossRef]
- 3) Yogeve-Seligmann G, Hausdorff JM, Giladi N: The role of executive function and attention in gait. *Mov Disord*, 2008, 23: 329–342, quiz 472. [Medline] [CrossRef]
- 4) Woollacott M, Shumway-Cook A: Attention and the control of posture and gait: a review of an emerging area of research. *Gait Posture*, 2002, 16: 1–14. [Medline] [CrossRef]
- 5) Della Sala S, Baddeley A, Papagno C, et al.: Dual-task paradigm: a means to examine the central executive. *Ann N Y Acad Sci*, 1995, 769: 161–171. [Medline] [CrossRef]
- 6) Baddeley A: Working memory: looking back and looking forward. *Nat Rev Neurosci*, 2003, 4: 829–839. [Medline] [CrossRef]
- 7) Al-Yahya E, Dawes H, Smith L, et al.: Cognitive motor interference while walking: a systematic review and meta-analysis. *Neurosci Biobehav Rev*, 2011, 35: 715–728. [Medline] [CrossRef]
- 8) Lundin-Olsson L, Nyberg L, Gustafson Y: “Stops walking when talking” as a predictor of falls in elderly people. *Lancet*, 1997, 349: 617. [Medline] [CrossRef]
- 9) Beauchet O, Anweiler C, Dubost V, et al.: Stops walking when talking: a predictor of falls in older adults? *Eur J Neurol*, 2009, 16: 786–795. [Medline] [CrossRef]
- 10) Muir-Hunter SW, Wittwer JE: Dual-task testing to predict falls in community-dwelling older adults: a systematic review. *Physiotherapy*, 2016, 102: 29–40. [Medline] [CrossRef]
- 11) Mendel T, Barbosa WO, Sasaki AC: Dual task training as a therapeutic strategy in neurologic physical therapy: a literature review. *Acta Fisiatr*, 2015, 22: 206–211.
- 12) Verghese J, Kuslansky G, Holtzer R, et al.: Walking while talking: effect of task prioritization in the elderly. *Arch Phys Med Rehabil*, 2007, 88: 50–53. [Medline] [CrossRef]
- 13) Plummer P, Eskes G, Wallace S, et al. American Congress of Rehabilitation Medicine Stroke Networking Group Cognition Task Force: Cognitive-motor interference during functional mobility after stroke: state of the science and implications for future research. *Arch Phys Med Rehabil*, 2013, 94: 2565–2574.e6. [Medline] [CrossRef]
- 14) Hyndman D, Ashburn A, Yardley L, et al.: Interference between balance, gait and cognitive task performance among people with stroke living in the community. *Disabil Rehabil*, 2006, 28: 849–856. [Medline] [CrossRef]
- 15) Weerdesteyn V, de Niet M, van Duijnhoven HJ, et al.: Falls in individuals with stroke. *J Rehabil Res Dev*, 2008, 45: 1195–1213. [Medline] [CrossRef]
- 16) Shumway-Cook A, Woollacott M, Kerns KA, et al.: The effects of two types of cognitive tasks on postural stability in older adults with and without a history of falls. *J Gerontol A Biol Sci Med Sci*, 1997, 52: M232–M240. [Medline] [CrossRef]
- 17) Bloem BR, Grimbergen YA, van Dijk JG, et al.: The “posture second” strategy: a review of wrong priorities in Parkinson’s disease. *J Neurol Sci*, 2006, 248: 196–204. [Medline] [CrossRef]
- 18) Spildooren J, Vercurysse S, Desloovere K, et al.: Freezing of gait in Parkinson’s disease: the impact of dual-tasking and turning. *Mov Disord*, 2010, 25: 2563–2570. [Medline] [CrossRef]
- 19) Yogeve-Seligmann G, Rotem-Galili Y, Dickstein R, et al.: Effects of explicit prioritization on dual task walking in patients with Parkinson’s disease. *Gait Pos-*

- ture, 2012, 35: 641–646. [[Medline](#)] [[CrossRef](#)]
- 20) Beauchet O, Dubost V, Aminian K, et al.: Dual-task-related gait changes in the elderly: does the type of cognitive task matter? *J Mot Behav*, 2005, 37: 259–264. [[Medline](#)]
 - 21) Hausdorff JM, Schweiger A, Herman T, et al.: Dual-task decrements in gait: contributing factors among healthy older adults. *J Gerontol A Biol Sci Med Sci*, 2008, 63: 1335–1343. [[Medline](#)] [[CrossRef](#)]
 - 22) Maclean LM, Brown LJ, Khadra H, et al.: Observing prioritization effects on cognition and gait: the effect of increased cognitive load on cognitively healthy older adults' dual-task performance. *Gait Posture*, 2017, 53: 139–144. [[Medline](#)] [[CrossRef](#)]
 - 23) Smulders K, van Swigchem R, de Swart BJ, et al.: Community-dwelling people with chronic stroke need disproportionate attention while walking and negotiating obstacles. *Gait Posture*, 2012, 36: 127–132. [[Medline](#)] [[CrossRef](#)]
 - 24) Tombaugh TN: Trail making test A and B: normative data stratified by age and education. *Arch Clin Neuropsychol*, 2004, 19: 203–214. [[Medline](#)] [[CrossRef](#)]
 - 25) Fugl-Meyer AR, Jääskö L, Leyman I, et al.: The post-stroke hemiplegic patient. 1. a method for evaluation of physical performance. *Scand J Rehabil Med*, 1975, 7: 13–31. [[Medline](#)]
 - 26) Holden MK, Gill KM, Magliozzi MR, et al.: Clinical gait assessment in the neurologically impaired. Reliability and meaningfulness. *Phys Ther*, 1984, 64: 35–40. [[Medline](#)] [[CrossRef](#)]
 - 27) Iwase H, Murata S, Hioki Y, et al.: The relationship between the TMT-A and MMSE: examination of a simple method to identify dementia. *Jpn J Health Promot Phys Ther*, 2013, 3: 1–4 (in Japanese). [[CrossRef](#)]
 - 28) Ohzuno T, Harada A, Usuda S: Effects of cognitive task difficulty and task prioritization on dual task strategy in young healthy adults. *Rigakuryoho Kagaku*, 2017, 32: 917–921 (in Japanese). [[CrossRef](#)]
 - 29) Cockburn J, Haggard P, Cock J, et al.: Changing patterns of cognitive-motor interference (CMI) over time during recovery from stroke. *Clin Rehabil*, 2003, 17: 167–173. [[Medline](#)] [[CrossRef](#)]
 - 30) Hyndman D, Pickering RM, Ashburn A: Reduced sway during dual task balance performance among people with stroke at 6 and 12 months after discharge from hospital. *Neurorehabil Neural Repair*, 2009, 23: 847–854. [[Medline](#)] [[CrossRef](#)]
 - 31) Plummer P, Villalobos RM, Vayda MS, et al.: Feasibility of dual-task gait training for community-dwelling adults after stroke: a case series. *Stroke Res Treat*, 2014, 2014: 538602. [[Medline](#)]
 - 32) Liu YC, Yang YR, Tsai YA, et al.: Cognitive and motor dual task gait training improve dual task gait performance after stroke—a randomized controlled pilot trial. *Sci Rep*, 2017, 7: 4070. [[Medline](#)] [[CrossRef](#)]