A Home-Based Intervention to Improve Balance, Gait and Self-Confidence in Older Adults

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Abstract:
The effects of a low- to moderate-intensity balance program for older adults emphasizing self-efficacy information were examined. Participants were assigned to an exercise group with a self-efficacy intervention or as exercise-only controls. Efficacy information focused on mastery experiences and social persuasion. Older adults were pre- and post-tested before a 16-week, self-paced program. Post-testing revealed that adherence was higher for the efficacy intervention group. No significant main or interaction effects occurred for balance and mobility measures ($p > .05$). The efficacy intervention in this investigation resulted in greater adherence to activity, without concomitant improvements in balance and mobility. Results suggested that mastery information given participants was not sufficiently salient to result in balance improvements.
Keywords: Aging, balance, exercise intervention

Article:
Nearly half of the changes in physical functioning observed with aging have been attributed to disuse or inactivity (O'Brien-Cousins, 1998). According to the Department of Health and Human Services (2001) in the *Healthy People: 2010* report, 40% of adults 18 years and older participated in no leisure time physical activity in 1997. These low rates of participation continue to occur despite the acknowledged benefits of physical activity, such as cardiovascular fitness, strength, functional capacity, and psychosocial well-being. A myriad of reasons are cited by older adults for this lack of physical activity (O'Brien-Cousins & Janzen, 1998), including health concerns (falling, joint and muscle pain and exacerbation of a health condition), social concerns (disapproval of family and physician, and no companionship during exercise), and psychological concerns (wasting time, fear of failure, poor performance). These barriers to physical activity and exercise often are modulated by positive aspects, such as feeling and looking better, and delaying the on-set of particular diseases.

Despite these barriers, physical activity as a method to enhance strength and functional capacity in older adults has been widely examined. Previous research demonstrated increased leg strength, improvements in gait velocity, and decreased reliance on walking aids (Fiatarone, Marks et al., 1990; Fiatarone, O'Neill et al., 1994; Williams, Gill et al., 2000). Other investigations resulted in reduced pain and physical disability in participants (Ettinger, Burns, Messier et al., 1997). Many of these successful exercise intervention programs have been held in organized, group settings, with access to sophisticated exercise equipment, trained personnel, and social support. In contrast, many elderly adults are shown to benefit similarly from home-based exercise programs (Atienza, 2001). Regardless of the exercise program format (group- or home-based setting), motivating individuals of any age to continue exercising once they have begun remains a challenge. Many intervention studies report drop-out rates as high as 50%, with little improvement over the past 15 years (King, Haskell et al.,1991; Morgan & Dishman, 2001; O'Neal & Blair, 2001). In some cases, adherence rates are higher in home-based investigations, compared with fitnesscenter-based interventions. Adherence rates are typically higher (around 70%) in clinical trials (King, Haskell et al., 1991; O'Neal & Blair, 2001). Additional contact by exercise trainers and investigators appears to contribute to a reduction in exercise barriers for these participants. Furthermore, attrition rates may increase with high intensity exercise. Consequently, lower levels of exercise intensity may result in better adherence and compliance, which fosters positive fitness-related effects (King, Haskell et al., 1991; King, Kiernan et al., 1997).

Compliance and adherence to exercise programs is problematic throughout the lifespan. The rapid onset of deleterious side effects coinciding with a physically inactive lifestyle is particularly troubling for older adults. Consequently, investigators have shifted their focus to the psychosocial determinants of physical activity. This shift is reflected in the selection of self-efficacy as a primary indicant of physical exercise participation, compliance, and adherence (Katula, McAuley, Mihalko et al., 1998; McAuley, Courneya et al., 1994). Self-efficacy (an individual's belief in their ability to perform necessary courses of action to meet situational demands) is the central component of social cognitive theory, which posits that humans are active agents in their lives with the power to choose their own behavior. Further, thoughts and actions result from a complex interaction between the individual, environment, and behavior, each of which is reciprocal, fluid, and evolving (Bandura, 1997). Therefore, self-efficacy is theorized to influence choice of activity, effort expenditure, persistence, and the individual's exercise experience.

McAuley and colleagues (McAuley, Blissmer et al., 2000), as well as other researchers (Katula, McAuley, Mihalko et al., 1998), provide support for social cognitive theory as an appropriate framework for understanding exercise behavior. For example, self-efficacy has been shown to be a determinant and outcome of physical exercise participation (McAuley, Pena et al., 2001). Additionally, it has been demonstrated that even one bout of exercise can enhance adults' self-efficacy (Katula, McAuley, Mihalko et al., 1998). Moreover, there is evidence that a specific focus on particular elements of self-efficacy information like mastery accomplishments, social modeling, and interpretation of physiological states results in better adherence to exercise in middle-aged and elderly participants (Katula, McAuley, Mihalko et al., 1998; McAuley, Courneya et al., 1994). Currently, research on the determinants of self-efficacy has focused on cardiovascular exercise (i.e., walking and jogging) in leisure or clinical groups, and individual laboratory environments (Katula, McAuley, Mihalko et al., 1998). Furthermore, the majority of exercise intervention investigations have examined behavioral outcomes (i.e., physical activity participation and mastery experiences) as the primary influence on self-efficacy. Therefore, the impact of a broad array of self-efficacy feedback, involving verbal, emotional, and mastery information, on exercise compliance and adherence in older adults is not clear.

The purpose of this investigation was to combine low- to moderate-intensity exercise with self-efficacy information in a home-based exercise program for individuals 70 years and older. Specifically, self-efficacy information emphasized verbal feedback (general versus individualized) concerning mastery accomplishments. Home-based exercises focused on balance and mobility activities aimed at improving the performance of challenging activities of daily living (i.e., walking across slippery surfaces or through crowded areas like malls, and reaching into high cabinets). Thus, it was hypothesized that participants in a low- to moderate-intensity exercise program, which emphasized specific feedback to enhance self-efficacy, would exercise on more days than participants in a comparable program who did not receive this intervention. As a result, these exercise efficacy intervention participants would demonstrate greater improvements on a battery of balance related tests than individuals who participated in a balance activity program without additional efficacy information.

METHODS

Participants: Fifty-four older adults (mean age = 82.8 years, SD = 6.54, range = 75-97 years) were recruited to participate in this investigation. Participants were recruited from three separate retirement communities in Greensboro, NC. Most of the residents of these communities were white, middle-income professionals.

Prospective participants were examined by a geriatric nurse practitioner or completed a medical questionnaire prior to their participation. Given the low intensity of activities required in this intervention, only individuals with active heart or lung disease, or recent orthopedic injury (especially hip or knee replacements) were excluded. Study procedures were explained to prospective participants, who then read and signed an approved consent form.

Half of the participants were randomly assigned to a physical exercise only group (n = 27, Mean age = 83.7 years), and the other half to an exercise and efficacy intervention (n = 27, Mean age = 81.9 years). A modified random assignment procedure was implemented for married couples, who were assigned to the same group. In these cases, adjustments were made in order to balance the number of individuals in each group.

Pre- and Post-test Measures: A battery of balance, mobility and psychological measures was administered individually to each participant, pre- and post-intervention. Motor measures included the multidirectional reach test (MDRT, Newton, 2001), timed up and go (TUG, Podsiadlo and Richardson, 1991), tandem and semi-tandem stance (Rantanen et al., 1998), typical and fastest walking speeds, and stepping over obstacles of two different heights. Psychological measures included the Activities-specific Balance Confidence Scale (ABC, Powell & Myers, 1995) and the Vitality Plus Scale (VPS, Myers, Malott et al., 1999).

For the Multidirectional Reach Test, participants stood next to a meter stick fixed parallel to the floor, which was aligned with their outstretched arms. Participants leaned as far as they could in each of four directions: front, back, left and right, without bending at the waist, taking a step, or falling. To insure safety, an assistant stood to the side and behind the individual during the testing in the event of a loss of balance. Scores were recorded as a difference between beginning and ending positions. Three trials were performed in each direction. The average of the three trials was used in data analyses. For the timed up and go, participants began seated in a chair without arms. On a “go” signal, they are instructed to stand, walk 10 feet to cross a line, turn, walk back and be seated in the chair. Participants completed three trials at their preferred walking speed. The times were averaged across trials and the mean was used for data analyses. Tandem and semi-tandem stance were stationary balance measures. The semi-tandem stance required participants to stand with the heel of one foot contacting the arch and toes of the other. The tandem stance required participants to balance with the heel of one foot contacting the toes of the other. Participants were timed while balancing in each of these stances for a maximum of 10 seconds. Three attempts were given for each stance, with the maximum time recorded for use in analyses. To determine walking speeds, participants were videotaped while walking 10 feet. They performed three trials each at their preferred and fastest walking speeds. In addition, participants performed three trials in which they stepped over a low (5.1 cm, the height of a threshold between rooms) and high object (15.3 cm, the approximate height of a curbstone). Average speed was obtained using a standard VHS video camera placed perpendicular to the participant and approximately 10 feet from the walkway. Speeds were obtained by transferring the video data to a Peak Performance Motion Analysis system (Peak Performance Technologies, Englewood, CO) and digitizing the hip of each participant throughout three full strides of the walking trial. An average speed across strides and trials was determined for each condition.

The Activities Specific Balance Confidence Scale assesses self-efficacy by asking participants to rate their confidence in performing a series of activities (e.g., reaching an object at eye level, walking in a crowd) without losing their balance. Test-retest reliability is high (r = .92–Powell & Myers, 1995). Additional testing demonstrated that individuals with a history of falls rated their balance self-efficacy lower than those who had not fallen. Administration of the ABC requires that individuals rate their confidence on a 0% (no confidence) to 100% (entirely confident) scale. Ratings across the items are averaged for an overall level of balance self-efficacy. The Vitality Plus Scale measures the accumulated benefits of exercise participation by asking participants to rate their current feelings related to their perceptions of quality of life variables like energy level, stiffness, restlessness, etc. Participants rate each perception on a five-point scale. Scores for the 10 items are totaled for an overall score.

Intervention Protocol: Following pretesting, half the participants were assigned to a 16-week exercise group with a self-efficacy intervention; the remaining acted as exercise controls. All participants were provided with an illustrated notebook describing a series of graded exercises (see Appendix A for an example). They were asked to perform these exercises 4-5 days/week. An exercise professional met with each participant in his or her home to demonstrate the exercises and to make certain each activity was performed correctly. The instructor helped each participant individualize exercise protocols according to appropriate difficulty level. In addition, each participant received a weekly telephone call or home visit from the exercise instructor. During this time, participants were monitored to make certain activities were being performed correctly. Participants in both groups were given general encouragement for continuing their exercise. In addition, participants in the exercise/efficacy group were administered specific mastery accomplishment information.

Exercises included 11 activity progressions graded from less to increasingly more challenging. Mobility tasks included tandem and backward walking, arm raises, and chair rises (Appendix A). Balance tasks included stooping and crouching to pick up objects from seated and standing positions, standing on tiptoes, and standing on one foot while moving the other leg. The level of difficulty was increased by manipulating the amount of support participants used (from holding on to a stable surface to minimizing use of hands), or modifying head position (from standard to tipped backward).

Participants were given a logbook in which they recorded their exercise. They were asked to record each time they exercised as well as for how long. Participants were encouraged to write down any comments and reflections they had regarding the exercise program and their experiences.

Exercise/Efficacy Intervention: In-home follow-ups occurred every two weeks; participants were telephoned in alternate weeks. In addition to monitoring exercise patterns and encouraging progress through increasingly challenging activities, follow-up visits were used to administer efficacy information. The exercise professional reviewed each participant's exercise log with him or her during each visit. Using these logs, participants were encouraged (social persuasion) and given information regarding their progress/improvement (mastery experiences). A comparison of their exercise starting point was made with their current level at each visit as a way of demonstrating progress. Information was given regarding the length of time the exercises required. For example, for some participants, the time necessary to complete the exercises decreased with increased familiarity and practice. Conversely, some participants added exercises or increased their complexity as they became more confident, resulting in longer exercise periods. These situations were individually evaluated and the appropriate mastery information given.

Exercise (Nonefficacy) Controls: Exercise controls performed the same exercises performed by the intervention group. The only difference was the *type* of information these individuals received during follow-up visits. During the intervention period, the instructor contacted exercise control group participants by telephone or in person each week with questions regarding their participation. Participants were asked how many days they had performed the exercises, and whether they had fallen or been ill. Then, they were given general encouragement to continue exercising.

RESULTS

Exercise Adherence: Fifty-four individuals began the 16-week exercise and efficacy intervention program. Participants were visited or telephoned weekly in order to monitor their progress with the balance exercises and to administer efficacy information to the experimental group. Despite this weekly contact, nine of the exercise/efficacy treatment participants dropped out (33%), and 14 of the exercise control group ceased participating (52%). Furthermore, individuals in the exercise/efficacy group averaged 2.3 days per week of activity, while control group participants completed the tasks an average of 1.6 days/week.

Balance Testing: A 2 × 2 (condition by time) repeated measures multivariate analysis of variance (MANOVA) was performed on measures of functional balance and efficacy for individuals who completed the 16-week program (Table 1). No significant main effects for group, time, or the group by time interaction occurred ($p > .05$).

Next, a 2 × 2 (condition by completion) MANOVA was performed on the pretest data (Table 2). Significant main effects were found for group ($F(8,384) = 2.4$, $p = .016$) and the interaction between activity group and program completion was significant ($F(8,384) = 2.3$, $p = .02$). These findings suggest that participants in the two groups were different initially, despite random assignment to a condition. Follow-up one-way ANOVAs indicated marginally significant differences for the backward lean ($p = .08$). No other differences approached significance. Between-group trends suggested that drop-outs completed the TUG more slowly and performed the tandem stand for a shorter period than those who completed the intervention. In addition, they performed more poorly in the multidirectional reach and were less confident than those who completed the intervention. Clearly, these pretest differences between the groups could contribute to their continued participation in a relatively long activity program.

Walking Velocity. A 2 × 2 (condition by time) repeated measures MANOVA was performed on the velocity data. No significant differences were found between groups or over time for any walking task (Table 3). Additionally, the interaction between intervention group and pre- and post-test was not significant (p >.0 1). As with the balance data, group and exercise adherence differences were examined for the pretest data. No significant differences were found for any factor or interaction, suggesting that initial group assignment and exercise adherence had no bearing on performance of the walking tasks ($p > .05$). Although no analysis resulted in statistically reliable findings, as with the balance analyses, those individuals who completed the intervention tended to walk slightly faster than participants who dropped out (Table 4).

TABLE 1. Average Balance Scores for Participants Who Completed 16-Week Activity Intervention

Group		Age	TUG (s)	Tandem (s)	Semi-tandem (s)	MDRT-F (cm)	MDRT-B (cm)	MDRT-L (cm)	MDRT-R (cm)	ABC	VPS
Efficacy Intervention	Pretest	84.2	11.8 (4.4)	5.4 (4.8)	9.1 (2.5)	8.2 (4.0)	7.1 (3.7)	8.7 (5.1)	9.4 (5.4)	71.6 (19.3)	41.5 (5.7)
	Posttest		11.6 (8.1)	5.4 (4.1)	9.1 (2.1)	8.0 (3.8)	7.0 (3.7)	9.1 (4.3)	9.4 (3.3)	77.2 (18.3)	40.9 (7.2)
Exercise only	Pretest	83.7	12.9 (4.9)	5.3 (4.2)	9.5 (1.9)	5.7 (4.6)	6.3 (3.8)	5.9 (3.1)	6.8 (3.5)	65.7 (19.1)	31.8 (5.2)
	Posttest		11.4 (3.5)	7.6 (3.8)	9.5 (1.5)	8.3 (2.9)	6.8 (2.0)	9.1 (2.8)	9.5 (3.4)	75.0 (20.4)	33.0 (7.4)

TABLE 2. Average Pretest Balance Scores for Participants Who Completed and Did Not Complete 16-Week Activity Intervention

Group	N	TUG (s)	Tandem (s)	Semi-Tandem (s)	MDRT-F (cm)	MDRT-B (cm)	MDRT-L (cm)	MDRT-R (cm)	ABC	VPS
Pre-test only: Exercise	14	16.1 (7.7)	3.7 (3.8)	9.4 (2.4)	5.7 (3.3)	4.7 (3.2)	7.1 (4.7)	8.1 (5.5)	59.0 (20.0)	35.2 (6.7)
Pre-test only: Efficacy	9	11.9 (4.2)	4.1 (3.5)	9.5 (0.9)	6.9 (2.2)	5.3 (2.9)	6.3 (2.8)	7.0 (3.7)	75.4 (15.4)	37.8 (10.3)
Pre- and post-test: Exercise	13	12.7 (4.5)	5.2 (4.3)	9.5 (1.7)	6.2 (4.4)	6.4 (3.7)	6.0 (2.9)	7.0 (3.5)	67.0 (18.1)	32.5 (5.2)
Pre- and post-test: Efficacy	18	13.4 (12.6)	4.8 (4.8)	9.4 (2.4)	6.9 (4.2)	6.3 (3.7)	7.0 (5.0)	7.8 (5.4)	69.2 (21.1)	36.9 (7.7)

DISCUSSION

The 16-week self-efficacy, and balance and mobility intervention used in this investigation resulted in improved exercise adherence for participants in the efficacy group. More individuals in the efficacy intervention remained in the program over the entire 16-week period. Individuals who received efficacy information about their performances also practiced balance activities more often than those in the exercise only group. Despite this difference in adherence, the 16-week home-based intervention failed to result in significant improvements in balance, balance self-confidence, and walking velocity for individuals in the exercise control group or the efficacy/exercise group.

Pretest scores demonstrated initial differences between those who completed the program and those who dropped out. Generally, individuals who dropped out moved slower, and scored lower on static balance tests than those who completed the program (Tables 2 and 4). Timed-up-and-go scores were longer (indicating poorer performance) for dropouts. Additionally, participants who discontinued held a tandem stance position for a shorter period than those who completed the program. They were less confident than those who adhered. In light of this information, pretest differences may have contributed to our failure to find posttest differences (Table 1), even though individuals were randomly assigned to activity groups.

The hypothesized improvements in balance and confidence following the efficacy intervention were based on previous work by McAuley and colleagues (McAuley, Courneya et al., 1994). They utilized moderate to high intensity walking interventions for middle-aged and older adults. Participants in these research interventions were given specific information regarding their performance, such as increases in distance and time walked (McAuley, 1994; McAuley, Courneya et al., 1994). In McAuley's experiments, individuals exercised more often, and for longer periods following an efficacy intervention. An attempt was made to give participants in the present investigation comparable mastery accomplishment information regarding their performance of balance tasks. For example, emphasis was placed on participants' abilities to progress to more complex tasks, and perform the activities more often or for longer periods. The results of this study support the work by McAuley and colleagues (McAuley, Courneya et al., 1994) by demonstrating that participants in the efficacy/exercise group exercised more often than individuals in the exercise control group. However, anecdotal evidence from the journals kept by the fitness instructors suggests that participants viewed finishing the prescribed exercises in less amount of time as a sign of improvement. As a result, evidence did not support previous research by demonstrating that individuals exercised for longer periods of time following the efficacy/exercise intervention. Moreover, the current research hypotheses of improvements in balance and self-efficacy, specifically that the efficacy/exercise intervention would produce larger improvements in balance and self-efficacy than the exercise control program, were not supported. Various factors may have contributed to the lack of improvement in balance and self-efficacy, particularly a lack of congruence in outcome expectations, optimally challenging balance activities and salient incentives.

TABLE 3. Average Walking Velocities for Participants Who Completed 16-Week Activity Intervention

Group		Preferred walking spd (m/s)	Fast walking speed (m/s)	Low obstacle (m/s)	High obstacle (m/s)
efficacy	Pretest	1.1 (.25)	1.3 (.28)	1.1 (.26)	1.1 (.21)
intervention	Posttest	1.1 (.19)	1.3 (.31)	1.1 (.30)	1.1 (.30)
exercise	Pretest	1.0 (.24)	1.3 (.31)	1.1 (.19)	1.1 (.20)
only	Posttest	1.1 (.30)	1.3 (.42)	1.2 (.31)	1.2 (.33)

Regarding expectations, it may be that the changes occurring as a result of balance training are more subtle and different than what individuals anticipated as a result of exercise participation. In turn, participants' perceptions regarding the balance improvements would not coincide with previously expected outcomes and would be less sensitive to the type of efficacy intervention used. For example, the information given to participants focused on their progress through more challenging balance activities. It may be that participants expected different indicants of balance improvement, rather than progress to more challenging tasks. Therefore, the efficacy information provided to balance participants might have been less salient than the information provided to McAuley and colleagues' walking participants. For example, it would appear that participants in the present investigation did not experience the kinds of physical changes often expected with exercise, such as sweating and increased respirations. Thus, it may be that the types of physiological experiences that occur in conjunction with even moderate intensity cardiovascular activity are more salient cues to an individual's progression. The failure to find change on the Vitality Plus Scale (quality of life) also points to this interpretation. The lack of change in the VPS suggests that individuals did not perceive the "typical" benefits of activity: improved appetite and sleep patterns, as well as other physical changes often associated with strenuous activity.

TABLE 4. Average Pretest Walking Velocities for Participants Who Completed and Did Not Complete 16-Week Activity Intervention

Group	Number	Preferred walking speed (m/s)	Fast walking speed (m/s)	Low obstacle (m/s)	High obstacle (m/s)
Pre-test only	21	.98 (.26)	1.2 (.40)	.97 (.28)	1.1 (.60)
Pre- and post-test	31	1.02 (.24)	1.3 (.34)	1.07 (.22)	1.1 (.38)

Additionally, if participants did not perceive an optimal challenge as a result of the absence of these types of physiological responses, efficacy feedback presented may have seemed irrelevant. Related to this is the level of intensity of the activities performed in this investigation compared with the cardiovascular exercise emphasized by McAuley and colleagues. The balance and mobility intervention was designed as a low- to moderate-form of activity, because there was evidence that some individuals would find it easier to adhere (King, Haskell et al., 1991; King, Kiernan et al., 1997). In contrast, McAuley and colleagues' interventions focused on cardiovascular activities at moderate to high levels of intensity. So, while efficacy information and a low to moderate intensity program may result in better adherence to activity, it may not be sufficient to result in balance or balance efficacy improvements.

An additional area for discussion is incentives. Participants in this investigation were offered no tangible incentives to participate (like t-shirts, etc.). Many of those who took part in this investigation may have viewed the weekly contact with an investigator as an important incentive. However, these contacts occurred regardless of how often or intensely they exercised. Therefore, the role of incentives in this particular study is somewhat unclear.

Lastly, the individuals who participated in this investigation were considerably older than those described in McAuley and colleagues' investigations. Participants in the present investigation averaged over 80 years, and their performance on many of the balance tasks suggested that they represented a fairly frail portion of the population. For example, their scores on the TUG placed them at the 20th percentile of performance when adjusted for distance walked (10 feet in the present study vs. 8 feet in Rikli & Jones, 2001). While many of them performed at ceiling (10s) on the semi-tandem stand, many had difficulty performing the 10s tandem stand at all (Table 1). Participants in this investigation were nearly 10 years older than those tested by Newton (2001) for the MDRT and averaged half the reaching distance she reported. Scores in the 60 to 70% range on the ABC suggested that they were not particularly confident regarding their balancing abilities, but demonstrated some improvement during the course of the intervention. However, given their scores, it may be that more intense balance training would be necessary in order to result in the improvements observed in other balance interventions (Hu & Woollacott, 1994; Rose & Clark, 2000).

In conclusion, the results of this 16-week balance and self-efficacy intervention supported the idea that efficacy information and low-intensity physical activities result in improved adherence and frequency of exercise. On the other hand, efficacy information and low-intensity balance activities failed to result in balance or balance efficacy improvements among the elderly individuals who participated. Given this, further study is necessary to determine whether the nature of the efficacy information was insufficient to bring about change, specifically with regard to outcome expectations. Additionally, the low intensity of the activities used should be further explored, with particular attention to providing an optimal challenge for participants.

APPENDIX A. Example of Graded Activity Progression for Balance and Mobility Training–Chair Rise[1]

Participants used a firm chair with arms to perform this activity:

Level 1. Sit comfortably in the chair. Stand up and sit down, **five** times in a row at a comfortable speed. Use your hands and arms to help push out of the chair, if necessary.

Level 2. Stand up and sit down, **ten** times in a row at a comfortable speed. Use your hands and arms to help push out of the chair, if necessary.

Level 3. Stand up and sit down, **five** times in a row consecutively, at a comfortable speed. **Do not** use your hands and arms to push out of the chair.

Level 4. Stand up and sit down, **ten** times in a row consecutively, at a comfortable speed. **Do not** use your hands and arms to push out of the chair.

[1]Copies of all the activity progressions are available from the authors.

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