The Dancing Mind: cognitive benefits of multi-dimensional physical activity in old age

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BACKGROUND: Cognitive decline has emerged as one of the greatest health threats in old age, with nearly 50% of adults aged 85 or over suffering from dementia. It is estimated that the number of people with dementia worldwide will nearly double every 20 years to 65.7 million in 2030 and 115.4 million in 2050. It is increasingly recognised that dementia may not be an inevitable outcome of ageing. Hence, identification of effective interventions that delay the onset of the disease or slow its progression, even if modestly, holds the promise of substantially reducing the national and individual burden of dementia.

Observational longitudinal studies suggest that regular physical activity can protect against cognitive decline and dementia. Yet, the optimal type of physical activity or the amount needed (dose) are far from being defined. Intervention research in this area focused on measuring cognitive improvements from regimens aiming to improve cardiovascular fitness or muscle strength under supervised conditions. However, in the real world, older Australian mostly engage in regular walking in their neighbourhood (45%), playing golf or bowls (10%), taking aerobic or calisthenics classes (9%), swimming (7%), playing tennis or cycling, (4%), dancing (3%) or doing taichi or yoga (1%). There is very little data about the cognitive benefits of any of these activities for older Australians and whether one stands out in relation to cognitive abilities.

Of all the above named activities, dance has been repeatedly highlighted as a potentially superior activity for improving cognitive ability, but with very limited evidence. Dance requires memorising of intricate sequences of steps, attention and concentration and continuous learning and mastery of motor skills. In recent years neuroscientists have used dance as a model for studying neural processes implicated in the execution, expression, and observation of skilled movement. This research has been devoted to comparison between young professional dancers and non-dancers, however some processes identified can apply to an older population.

A review of all dance -based interventions involving older adults up to 2009 highlighted that a range of dance styles improved balance, strength and mobility of older people. The RCTs (6 out of the 10 interventions identified) were small scale (≤50 participants), mostly (n=5) short term (10-15 weeks), and none examined effects on cognitive functions. Since then, five dance-based studies were published, three studies examined the effect of dance program on physical abilities or metabolic outcomes of older participants and two examined cognitive abilities. One study in Japan only investigated the acute change (immediately after a session) in cognitive ability of older seniors who participated in aerobic dance class, which is more of an aerobic exercise than social dancing. The second study conducted in France examined the impact of contemporary dance improvisation on attention control in older adults. Compared to T'ai chi or falls-prevention exercise the dance group selectively improved in their ability to switch attention between tasks, but not in setting or suppressing attention, after a six-month program. In this study, group allocation to intervention types was non-random which questions the validity of the findings as the effect may be explained by selection of participants to each program based on the specific cognitive abilities rather than the program itself.

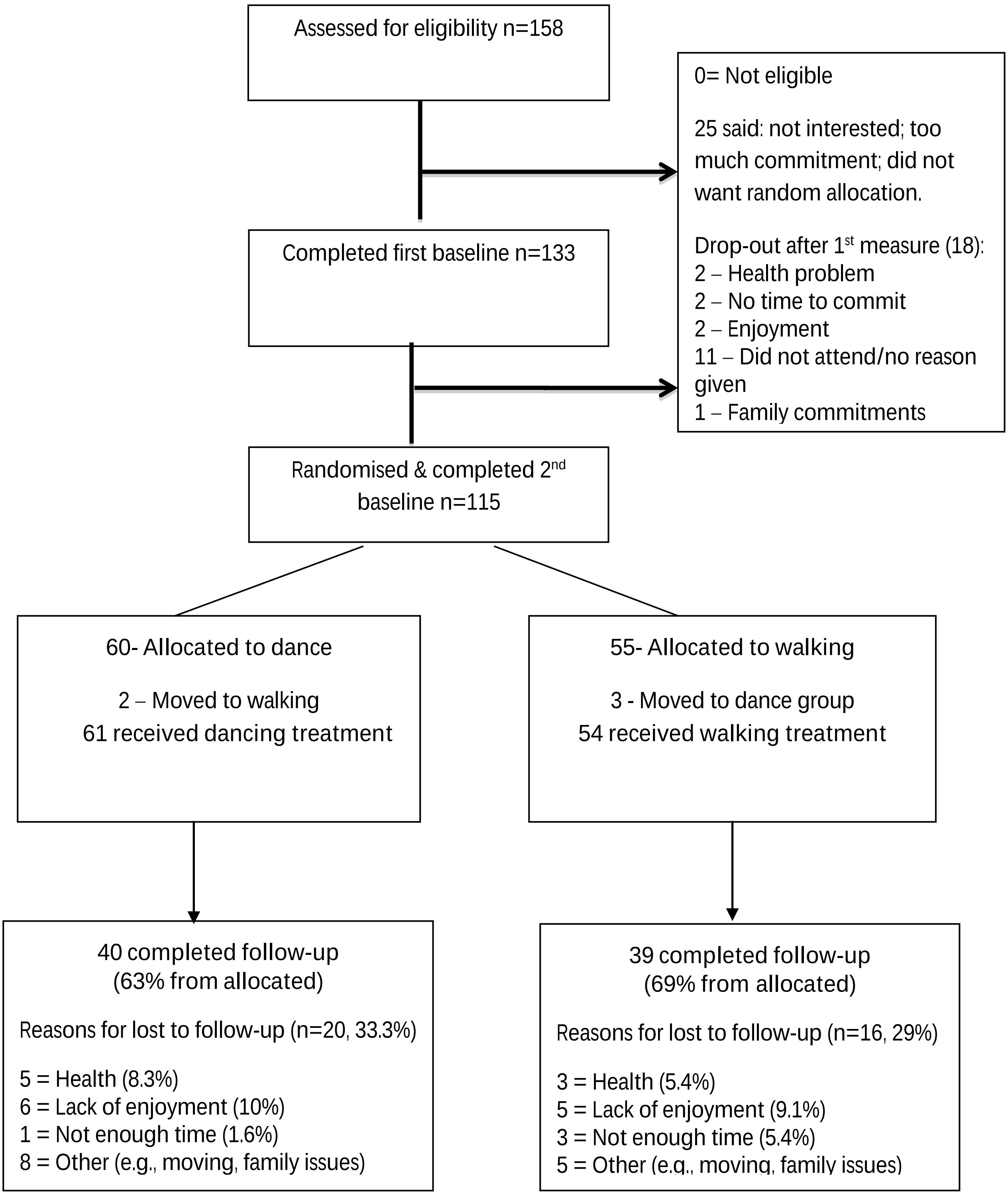
Given the paucity of empirical evidence for the cognitive benefits of social dancing in old age we conducted the first study to determine if typical community dance programs, currently available across Australia, can minimise age-related cognitive decline better than simple accessible activity such as walking.

AIMS: We hypothesised that ballroom dancing would be associated with greater improvement in cognitive tasks than a walking program of similar dose. We also hypothesised that improvement in fitness would not explain the improvement in cognitive function.

METHODS: We conducted a randomised controlled trial from April 2013 to September 2014 recruiting 115 participants in a staggered manner from Toongabbie, Richmond, Campbelltown, Penrith and Randwick. We screened participants for their cognitive status and for chronic conditions that would prevent them from doing regular exercise. We conducted two baseline measurements of cognitive tests, three weeks apart, to measure the effect of spontaneous learning due to measurement only. The cognitive measures are described along with the tests results (see page 4).

RESULTS: The figure below summarises the flow of participants before and after randomisation. As can be seen we lost potential participants due to not accepting the rule of randomisation. Hence five participants who completed two measurements at baseline were allowed to switch, despite different allocation to retain the sample size. We have analysed the study both as intention to treat (as randomised) and "treatment received" (according to the actual program they received) and it did not change the findings. We lost a similar proportion from walking (29%) and dance (33%) mainly due to moving out of area and mostly from non-English background. Yet it is important to note that in both groups a similar proportion of participants left the programs due to lack of enjoyment at about 9%-10%.

Flow Chart of Participants in the Dancing Mind Study



There were no differences between groups in the characteristics of participants. Participants were generally women (76%), half were 60-69 years old and 23% were 75 years old or above. Thirty percent had university degree and 85% were retirees. About 18% of study participants lived in geographical areas that are ranked at the two lowest quintiles of the NSW Socioeconomic Index of Area (SEIFA) advantage/disadvantage and additional 29% were from areas ranked in the third quintiles.

We found that those who left the study during the program and did not complete the follow-up cognitive testing had significant poorer performance on almost all baseline executive functioning tests than those who remained in the study.

We conducted five cognitive tests at three time points: 1) when joining the study, 2) 14-21 days after, and 3) after eight months from baseline. The table below summarises the mean changes in performance across the three time points for each group. The within group effects were measured from delayed baseline to eight-month follow-up. The between group effect indicates by how much the mean changes in dance and in walking were different from each other.

	Allocation group Dance (n=40)				Allocation group Walk (n=39)				
	Baseline	Delayed baseline	Follow-up*	group effect	Baseline	Delayed baseline	Follow-up*	group effect	Between groups effect
RAVLT1 - Immediate recall	6.45	6.45	6.83	0.144	6.05	6.05	6.51	0.114	-0.038
RAVLT7 - Delayed recall	9.32	9.2	9.15	0.546	9.18	9.15	8.9	0.691	0.070
TMTB total time (seconds)	88.5	90.2	96.6	0.808	100	92.3	98.5	0.831	0.003
TMTB-TMTA difference (seconds)	51.1	55.2	60.4	0.215	62.5	56	61.9	0.160	-0.019
Digits backwards	6.8	6.67	6.17	0.953	6.59	6.59	6.64	0.422	-0.319
Controlled Word	40.5	40.9	44.3	0.020	39.6	41.7	45.5	0.012	-0.029

Fluency (Total words)									
BVMT1 Immediate recall	4.22[a]	5.36	5.22	0.674	3.31	5.08	4.36	0.980	0.235
BVMT Total learning	20.1[a]	21.3	21.3	0.614	17.4	21.4	19.5	0.994	0.291
BVMT4- Delayed recall	8.41	8.03	8.72	0.121	7.72	8.28	8.56	0.818	0.343
Stroop trial 3 - trial 1 (seconds)	21.1	17.7	18.5	0.170	20	18.1	19	0.251	-0.017

The measures

Rey Auditory Verbal learning Test (RAVLT1) tested the ability to immediately recall a list of 15 words that were read to participants for the first time, the more the better (RAVLT1). The table shows that both groups improved similarly (effect =0.144). The next measure is delayed recall (RAVLT7) and measures the total words recalled after a 20-min delay and listening to the list five times (out of 15). This is a measure of longer term retention and retrieval of verbal information and is often associated with brain volume in memory areas. The table showed an average improvement in dance (0.546) and in walking (0.691). There were no significant differences between the groups (p=0.70).

Trial Making Test B (TMT B) measured the time taken to connect alternately between numbers and letters in the correct order: For example, from number 1 to the letter A then to number 2 to the letter B then to number 3 to letter C etc. Letters and number are randomly spread over an A4 size paper. This measure has repeatedly shown a correlation with driving safety and falls risk in older adults. The quicker the better, yet the participants in both groups increased the duration of this task. The next measure TMTA –TMTB measures the difference in time between simpler task (connecting only numbers in the right order) and the more complex TMTB (as above). The difference in time to complete B vs A may be a better measure of the executive component involved in the trails task – i.e., task switching and cognitive flexibility. Lower numbers at the eight-month follow-up would indicate better performance, however this was not the case in this study.

Digits Backwards measures maximum length of a digit sequence repeated correctly in reverse order. This is a measure of the amount of verbal information that can be stored and manipulated in 'working memory'. Overall both groups improved (dance by 0.953 digits and walking by 0.422), however the difference in favour of dance was not statistically significant.

Brief Visuospatial Memory Test – tests visual memory and learning. Participants were shown six Geometric visual designs in a 2x3 matrix. The stimulus is presented for 10 seconds, after which it is removed from view. BVMT1 is a measure of short-term retention of visual information. Both groups improved (dance by 0.674 and walking by 0.980) but there was no significant effect of intervention. Similarly BVMT total, which is a measure of acquisition of figural/spatial information generated by summing the scores from Trial 1, 2 and 3,. indicates no differences between the groups. The BVMT4-Delayed recall, which was done 25 minutes later (while participants were doing physical measurement) showed better performance - nearly significantly better for the dance group. The effect size was 0.343, which is considered fair, and was almost significant.

Stroop trial 3 - trial 1 (seconds) measures executive function. Participants need to name the colour of the word printed rather than reading the colour words. This measures the ability to suppress a pre-potent response (i.e., reading a word as written is an automatic response which has to be suppressed in order to respond with the ink colour). Both groups improved their performance relative to baseline, but no differences between groups emerged.

SUMMARY: The hypothesis that complex motor skills will results in greater improvements on cognitive tests compared to simple activity such as walking was not confirmed.

Our findings may have been compromised by a small sample of completers and selective attrition from dance class. The attrition seems unrelated to the program allocation as similar proportions of walkers and dancers left the study due to lack of enjoyment. Attrition due to other reasons, such as moving from area or family reasons, was more prevalent in the dancing group. Significantly, the latter participants had the greatest potential for improvement as they had significantly poorer performance on all tests at baseline compared with dancers who completed the study. In the walking group, attrition was apparently at random and the effects seen in the walking program were not selective (i.e., they included people who performed both well and poorly on baseline test, hence the potential for change in the walking group was greater).

There was a tendency for dance participants to demonstrate greater improvement in delayed visuospatial recall. This may reflect the cognitive domain that is most relevant in mastering the skill of ballroom dancing or any dance. If so, it supports the theory that older adults can improve brain capacity that is specific to the domain of training, but there is limited transfer across the domains.

Regardless, it is possible that the lack of superior effects of dance is due to the program: insufficient intensity (i.e., the dances taught were at comfortable pace); insufficient time to impact the brain; uneven implementation across teachers introducing heterogeneity in outcomes, especially given we had five different teachers.

Last, in this report we did not include the emotional and social changes that may have arisen from dance and walking. Yet the fact that about 40% of the dance participants decided to continue with the teacher and pay for the class suggests that such program was highly valued by these seniors. Likewise, more than half of the walkers that joined the study indicated they did so because they wanted to dance. As a courtesy we offered them 16 sessions of dance.

We suggest a repeated trial in more controlled conditions across centres (same teacher), of greater intensity (may be folk dance program) and a higher dose, at least three times a week for at least six months and assessment of other health-related domains.

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IRT Foundation directly aligns with IRT Group's mission to create age-friendly communities where older Australians can age without barriers.

We support research projects promoting a greater understanding of the ageing process and the care and wellbeing of seniors. IRT Foundation also funds community grants and educational activities.

IRT Group has committed over $1.6 million in grants to leading Australian researchers since 2009. By making a commitment to research and advocacy and by partnering with community groups and businesses IRT Foundation will fund programs and services to change people's perceptions of older Australians and of ageing.

Our Foundation is a key pillar of IRT's commitment to give back $20 million in community dividends by 2020. In doing so, we will create age-friendly communities – a society for all ages.

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