Healthy Body Healthy Mind: the Effect of Varying Dual Task Demand

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Introduction

- Are we able to successfully multi-task?
- Can we do anything to improve our ability to multi-task?

Dual Task Method

- Widely implemented paradigm in multi-tasking or divided attention studies
- Simultaneous coordination of two or more tasks
- Target one or multiple cognitive domains

Alzheimer's & Dual Tasking

- AD patients significantly impaired performance under dual task conditions compared to healthy controls
  - dual task cost 18-28% Vs. 2-11%
- Support existence of specific dual task coordination mechanism in the healthy brain, impaired in AD patients
- Suggestion observed dual task cost resultant from two separate cognitive processes being utilised i.e. digit span (WM) and Tracking (visuo-spatial/perceptuomotor skills)
  - Studies requiring simultaneous performance of tasks using same domain did not result in significantly lower performance than observed when two separate domains targeted

Benefits of Exercise

- Exercise beneficial for
  - General health
  - Memory
  - Learning
  - Slowing process of cognitive decline
  - Enhanced life satisfaction
  - Psychological well-being
  - Decreased anxiety and depression
  - Executive functioning
  - Faster reaction times

Aims

- Can the advantageous effects of exercise be applied to dual tasking performance?
- Are highly active, international athletes better equipped to perform a dual tasking paradigm than sedentary controls?
- Does dual tasking impose more demand on cognition than increasing the demand of a single task resulting in an overall dual task cost?

Tasks Used

- Research has shown beneficial effects of exercise more pronounced for tasks placing higher demand on cognitive system

⇒ varying demand conditions ranging from low to high demand

- Two tasks targeting two separate cognitive domains
  - Digit span (verbal working memory)
  - Tracking (visuo-spatial ability)

Titration

- If participants perform differently on initial single tasks trials, differences observed between groups would most likely be accentuated –> apparent dual task cost could be attributed to to initial differences in task performance
- Individual ability on initial single task trials titrated so that participants were performing at their own ability levels
- Assumed any variation on performance between single and dual task conditions due to demand incurred rather than initial differences in individual ability to perform each task

Hypotheses

- Both groups will experience significant effects of dual task demand
- In light of research demonstrating beneficial effects of exercise on memory and reaction time, swimmers would deal better with increasing cognitive demand
  - Expected that swimmers would display greater percentage accuracy in digit span tasks
  - Higher percentage time on target in tracking tasks relative to controls
- When task difficulty was titrated a small yet significant dual task cost would be observed (approx. 2 – 11%)
  - This cost would be greater for sedentary controls compared to the swimmer group

Participants

Swimmers

n = 20

Mean age = 20.75

Mean hours of physical activity per week = 26

Controls

n = 20

Mean age = 22.05

Mean hours of physical activity per week = 0.65

- Behavioral Risk Factor Surveillance System
  - Intentional exercise each week
  - General health, smoking, alcohol
- Digit span
  - Aurally presented sequence
  - Verbally repeat back sequence

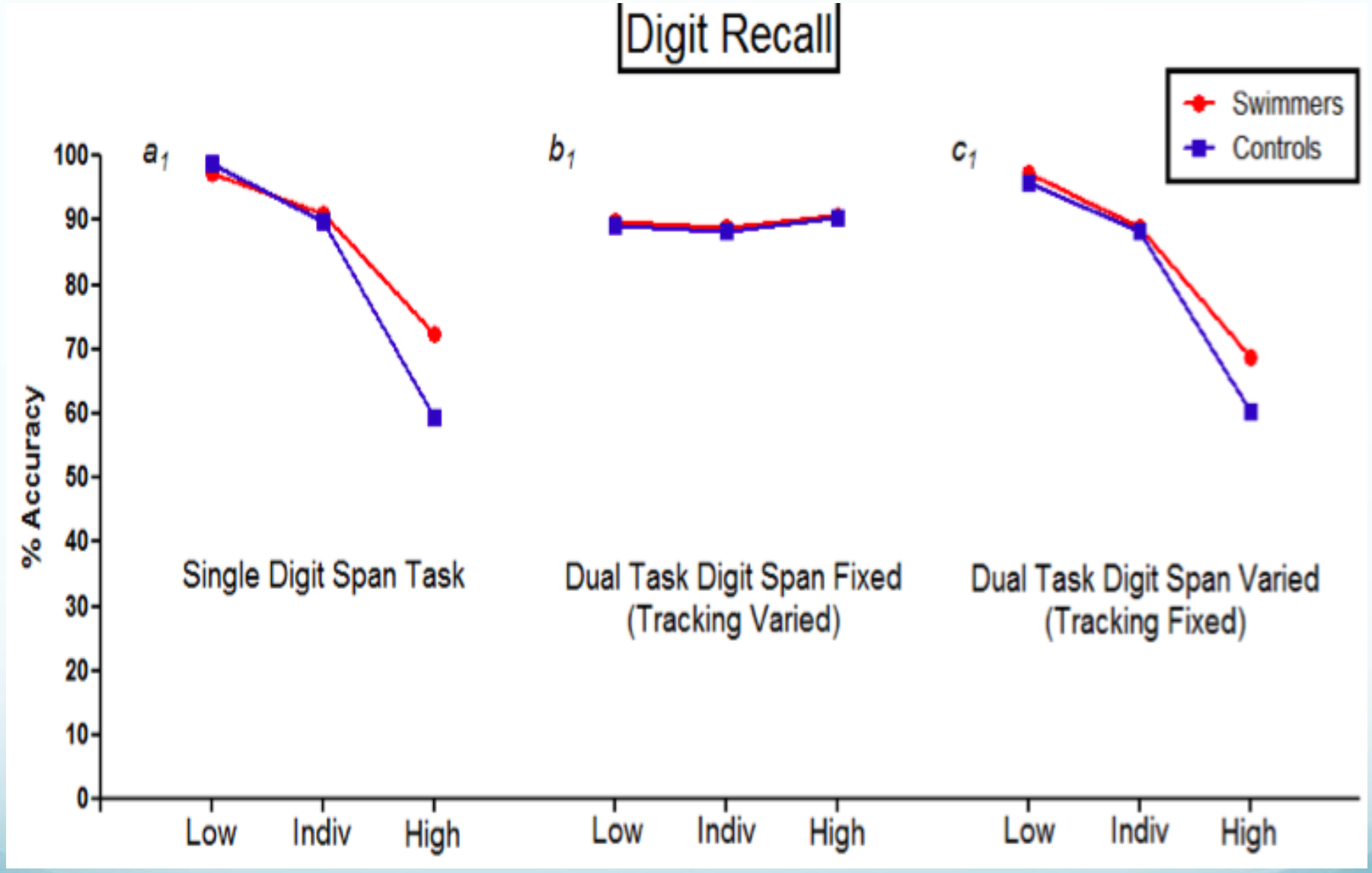
- Tracking
  - Light sensitive pen in contact with small oval shape
  - Maintain contact while moved around screen at random
  - Speed set at different levels
  - Speed increase of approx. 1 cm/s per level

Phase 1
Assess individual digit span and tracking level

Phase 2
Single task
Digit Span; a) at span -2 b) at span +2
Tracking; at level -2 b) at level +2

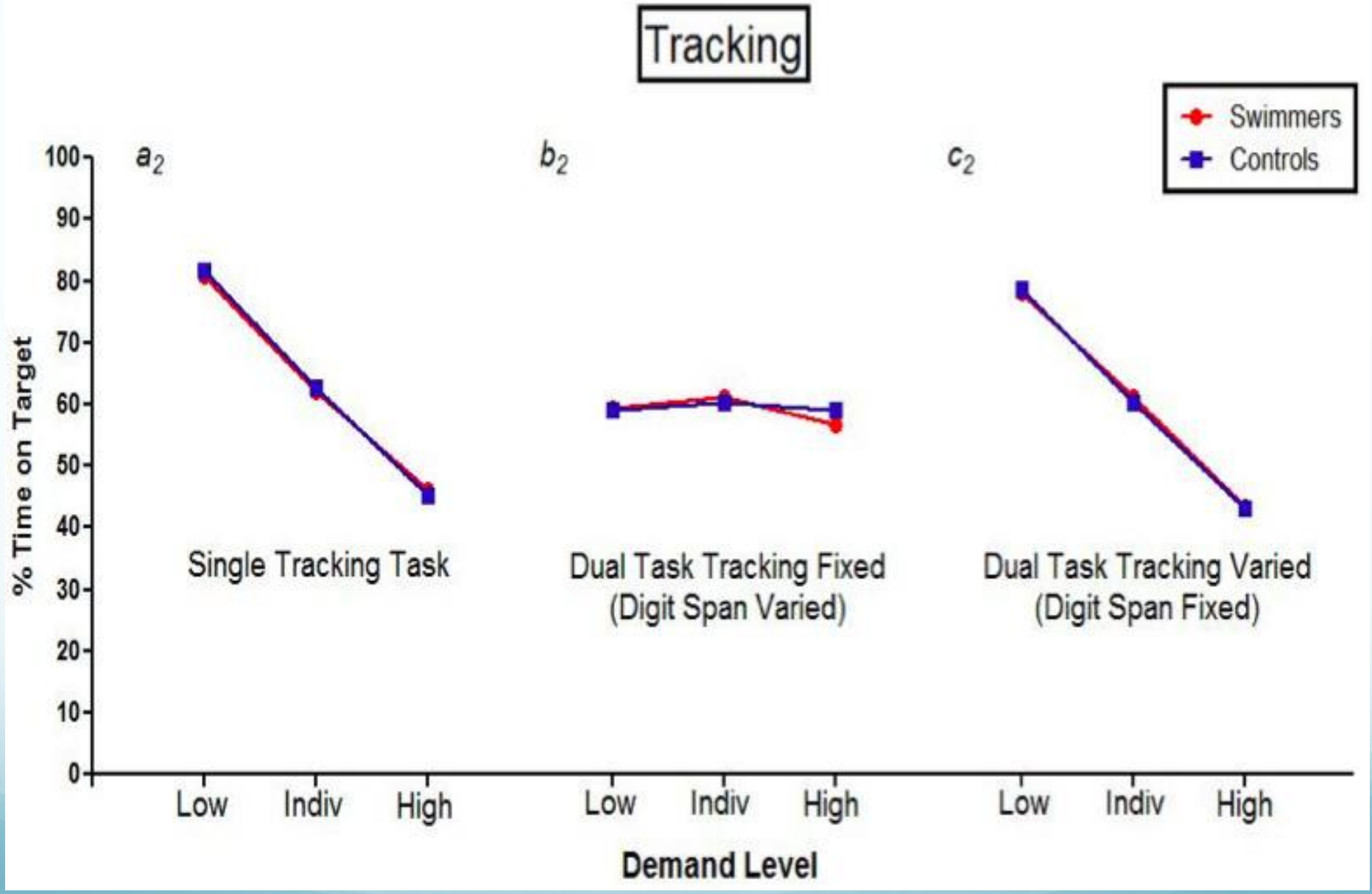
Phase 3
Dual Task
Tracking at individual level, digit span at span
Digit sequence constant; a) tracking level -2 b) tracking level +2
Tracking speed constant; a) digit span -2 b) digit span + 2

(counterbalanced)


Digit Recall
Swimmers
Controls
% Accuracy
100
90
80
70
60
50
40
30
20
10
0
a_1
b_1
c_1
Single Digit Span Task
Dual Task Digit Span Fixed
(Tracking Varied)
Dual Task Digit Span Varied
(Tracking Fixed)
Low
Indiv
High
Low
Indiv
High
Low
Indiv
High

Results
Single & Dual Task Digit Recall

- **a1:** recall performed as single task and sequence length varied, demonstrated a significant effect of demand but no group effect.
- **b1:** recall of fixed digit sequences at individual level concurrently with tracking demand varied, revealed no significant effect of demand or group.
- **c1:** recall of varied length of digit sequences concurrently with tracking demand fixed at span, revealed a significant effect of demand but no group effects.


Tracking
Swimmers
Controls
a_2
b_2
c_2
100
90
80
70
60
50
40
30
20
10
0
% Time on Target
Single Tracking Task
Dual Task Tracking Fixed
(Digit Span Varied)
Dual Task Tracking Varied
(Digit Span Fixed)
Low
Indiv
High
Low
Indiv
High
Low
Indiv
High
Demand Level

Results
Single & Dual Task Tracking

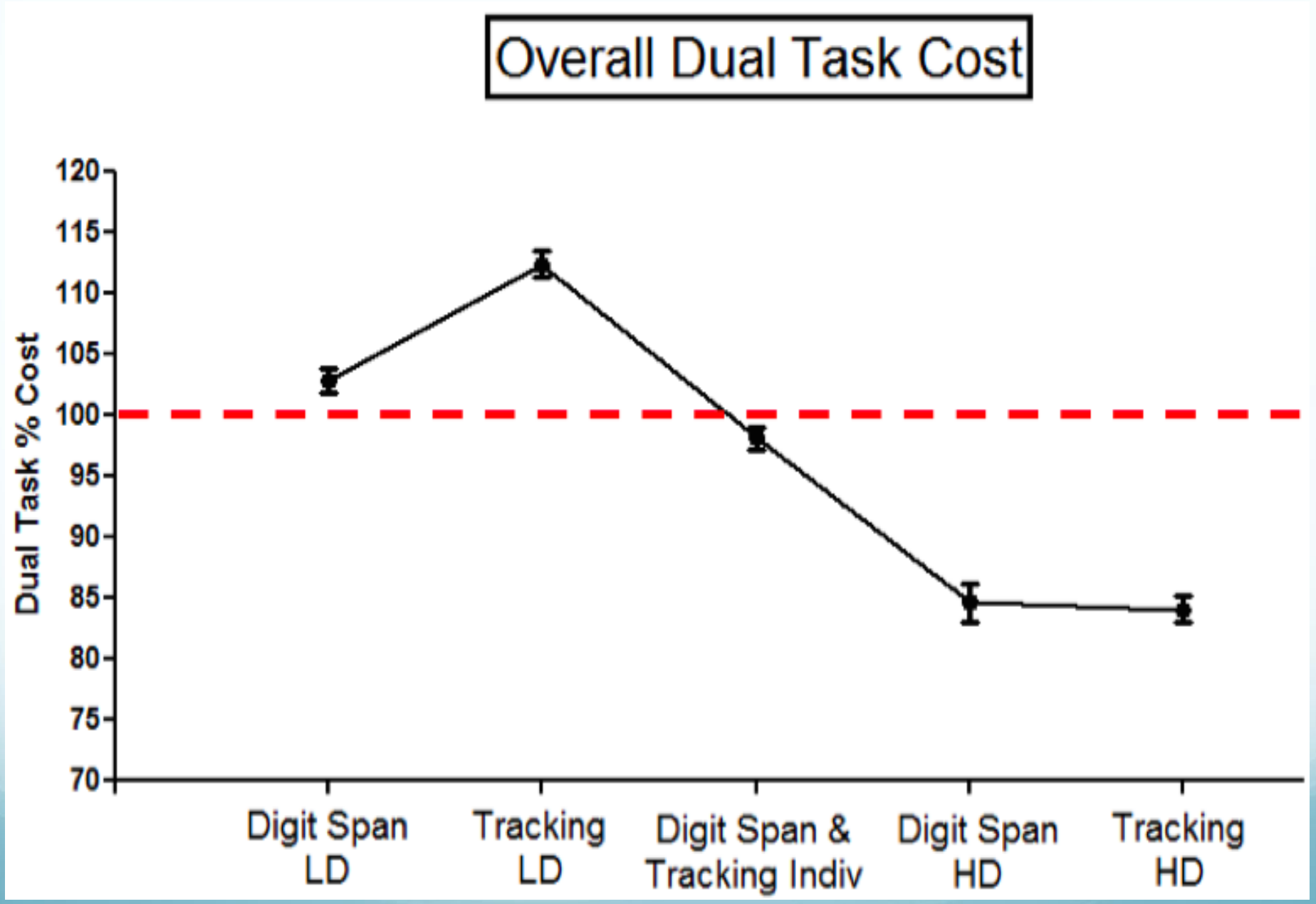
- **a2:** tracking performed as single task and demand level varied, demonstrated a significant effect of demand but no group effect
- **b2**: tracking demand fixed at individual level concurrently with digit sequence length varied, revealed a significant effect of demand, but no significant group effect. Further investigation showed that the significant effect of demand existed only between the digit at individual level and digit at high demand conditions
- **c2:** tracking performance when demand varied concurrently with digit sequence length fixed at span, revealed a significant main effect of demand but no effect of group.

Overall Dual Task Cost

- Gain accurate account of overall dual task cost, compared to performing single task
- Measure combined change in percentage accuracy across both single and dual task for both tasks
- No group differences => data collapsed n = 40

<u>5 dual task conditions</u>

1) Digit span at individual level, tracking at individual level
2) Digit span at high demand, tracking at individual level
3) Digit span at low demand, tracking at individual level
4) Tracking at high demand, digit span at individual level
5) Tracking at low demand, digit span at individual level


Overall Dual Task Cost
Dual Task % Cost
120
115
110
105
100
95
90
85
80
75
70
Digit Span LD
Tracking LD
Digit Span & Tracking Indiv
Digit Span HD
Tracking HD

Results
Overall Dual Task Cost

- **Low demand conditions**
  - Digit span demonstrated a minor improvement in performance (2.9%) with tracking returning a small overall advantage (12.4%).
- **High demand conditions**
  - These resulted in a moderate drop in performance (15.4 – 15.9%) compared to single task condition.
- **Individual level**
  - A minimal drop observed (1.9%)

Post hoc analysis

- Bonferroni adjustment $p < .005$
- Significant difference between all ten pairs of conditions ($p \leq .001$)
- Exception digit span and tracking high demand conditions - no significant difference

Discussion

- Results recorded failed to support the hypothesis that highly physically fit individuals would be better equipped to deal with the increasing cognitive demand inherent in the progression from low to high demand conditions
- However data suggests possible beneficial effect of exercise in high demand digit recall conditions
- There was a significant, but minimal, dual task cost found in this sample of young healthy adults which fell at the lower end of the magnitude of scores previously reported (2-11%)
- Results supported the existence of specific dual task co-ordination mechanism within a multi-component working memory system, which facilitates the parallel operation of two separate, domain specific cognitive resources

Discussion

- Future directions – possible explanations
  - Type of exercise engaged in
  - Age effects on dual tasking performance
  - Age effects in the potential benefits to cognitive function

- Investigate whether beneficial effects of exercise would be found if an exercise intervention that utilises the specific cognitive skills employed in dual taking was applied to sample previously displaying impaired dual taking performance e.g. AD.

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Thank you