# Memory Aids in Neurorehabilitation

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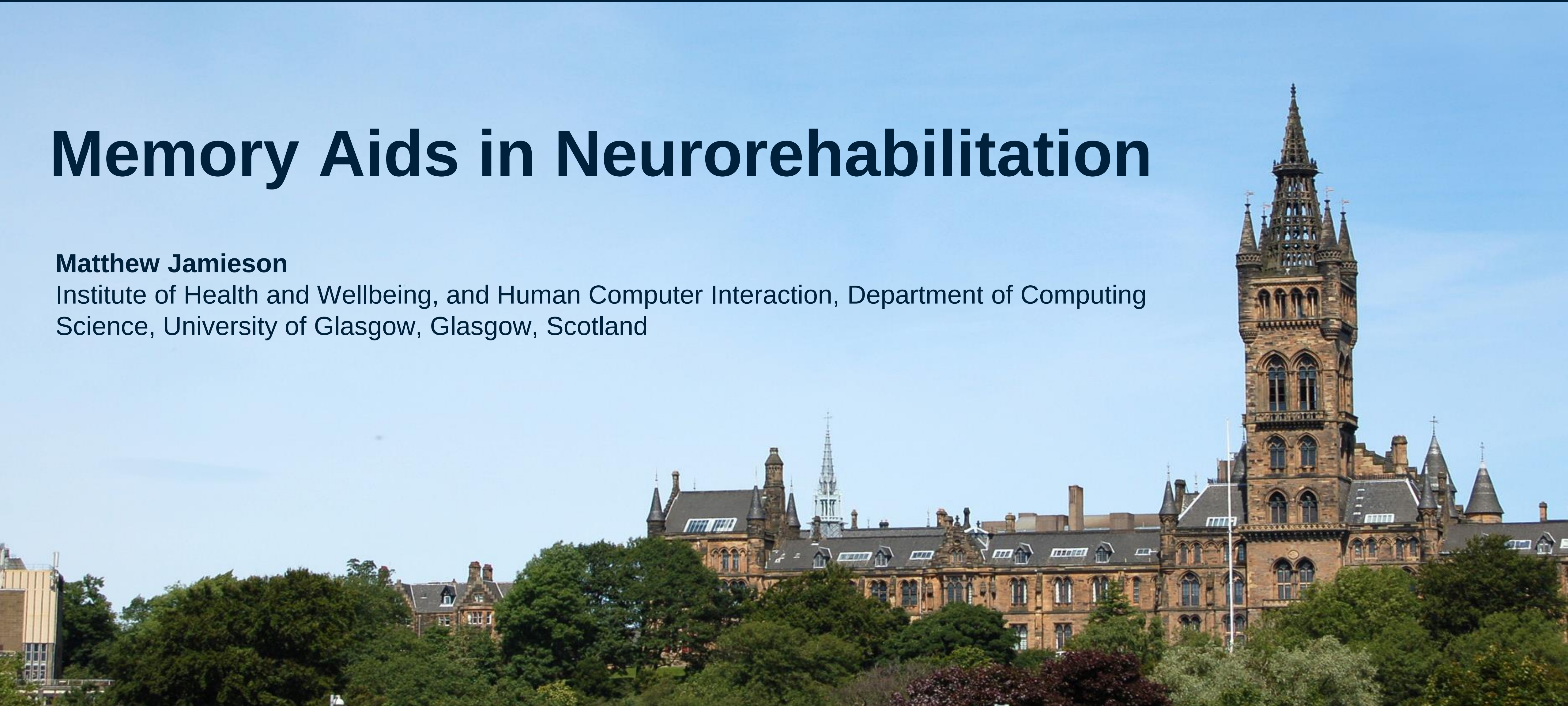


# Overview

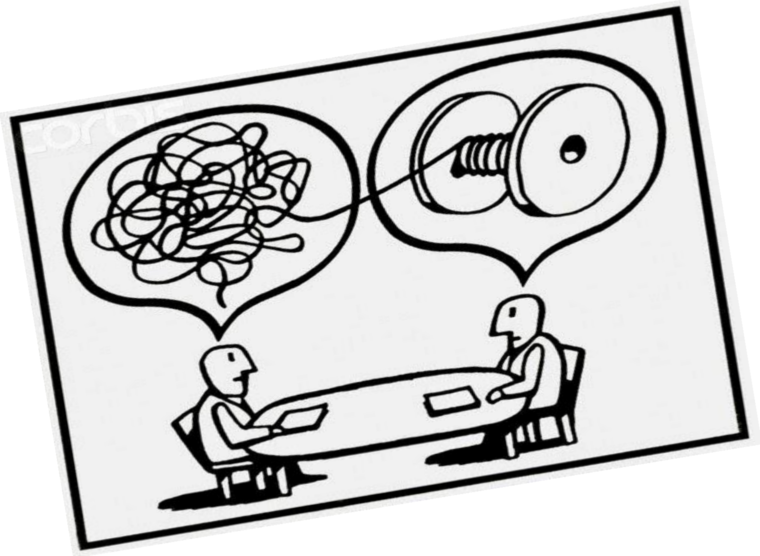
- Assistive and memory aid technologies
- Prospective memory – evidence base, promise and limitations
- Describing and investigating the use of prospective memory technologies
- Future research directions

- Summary:

- assistive technology is needed, works and needs to be used more
- user and UI needs may be different
- Neuropsychology researchers must collaborate to create and utilise the right technologies

# Background

Memory and executive impairments are highly prevalent after brain injury.



Clinicians, occupational therapists, support workers and carers can support people by prompting to help memory and task sequencing and by helping people learn new memory and planning strategies.

# Assistive Technology for Cognition

**Cognitive Difficulties**

(e.g.)
Executive Function

Memory

Attention

**Aim for Clinicians or Service User**

Compensation of abilities

Remediation

Assessment

# Assistive Technology for Memory

**Memory Difficulties**

Retrospective memory

Prospective memory

Working memory

**Aim for Clinicians or Service User**

Compensation of abilities

Remediation

Assessment

# Retrospective memory - compensation


Hodges, S., Williams, L., Berry, E., Izadi, S., Srinivasan, J., Butler, A., ... & Wood, K. (2006, September). SenseCam: A retrospective memory aid. In *International Conference on Ubiquitous Computing* (pp. 177-193). Springer, Berlin, Heidelberg.

# Working memory - compensation

Mihailidis, A., Boger, J. N., Craig, T., & Hoey, J. (2008). The COACH prompting system to assist older adults with dementia through handwashing: An efficacy study. *BMC geriatrics*, *8*(1), 28.

# Prospective memory – compensation

Different technologies have been shown to be helpful when prompting people at the correct time:




(Wilson et al., 2001) (Svoboda et al., 2010) (Jamieson et al., 2017)

# PM prompting evidence base

Systematic review of paper Methodology and Efficacy

***794*** articles found in initial search

Inclusion criteria = papers investigating the efficacy of prompting and micro-prompting devices on performance of everyday activities which require memory for people with memory impairments (stroke, ABI and degenerative disease groups).

***11*** group studies

***7*** of these could be included in a meta-analysis

***32*** single case experimental design papers

Non-overlap of all pairs (NAP) analysis could be performed on ***17*** of these studies

# Meta-analysis

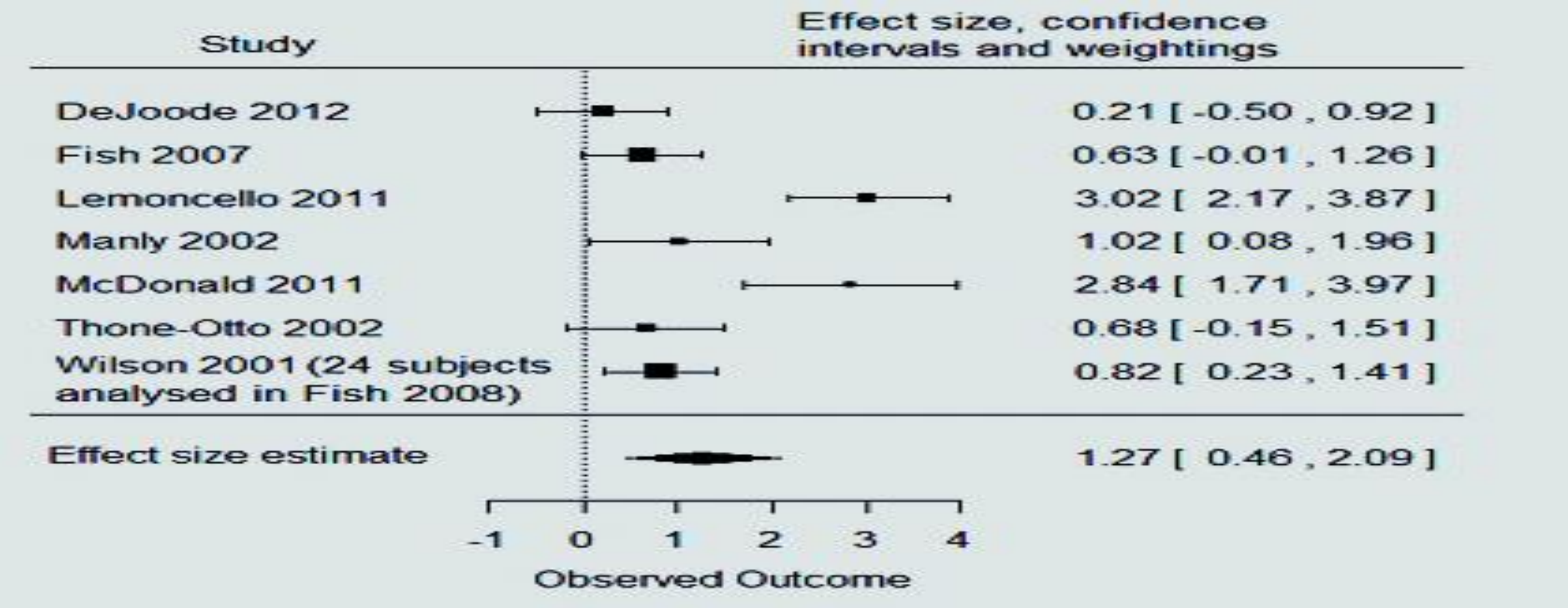
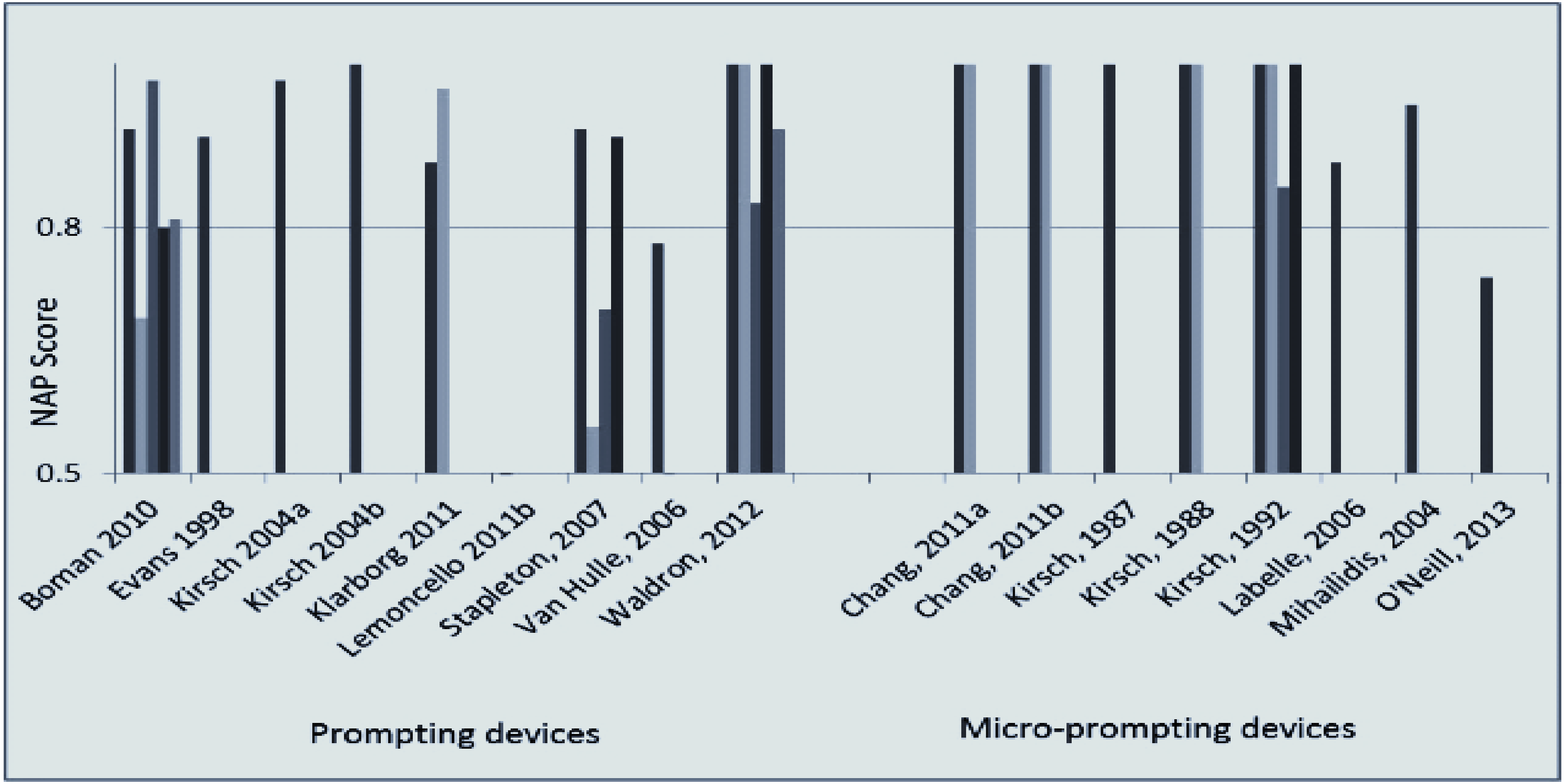



Figure 2. Meta-analysis results with effect sizes, confidence intervals and weightings for each individual study.

# Meta-analysis



# PM prompting evidence base

Prompting devices – convincing group study evidence

Meta analysis = d = 1.27 (n= 147) (above 0.8 = large effect size)

Micro-prompting devices – no convincing group study evidence.

Convincing single case study evidence

NAP mean for micro-prompting studies = 0.96/1 (n= 14)

(above 0.92 is a large effect size)

# Evidence base - Limitations

**Did not (always) require participants to enter the reminders into the device.**

**They also mostly focussed on non-smartphone devices such as a PDA and pager.**

**Less about people’s experience, acceptability, or accessibility using these devices.**

# Survey

Do people with memory impairments after ABI currently use ATC?

If so what technology do they use?

How useful do they find it?

Who makes best use of memory aids?

# Survey Method

Mobile phone

Self reported memory (PRMQ)

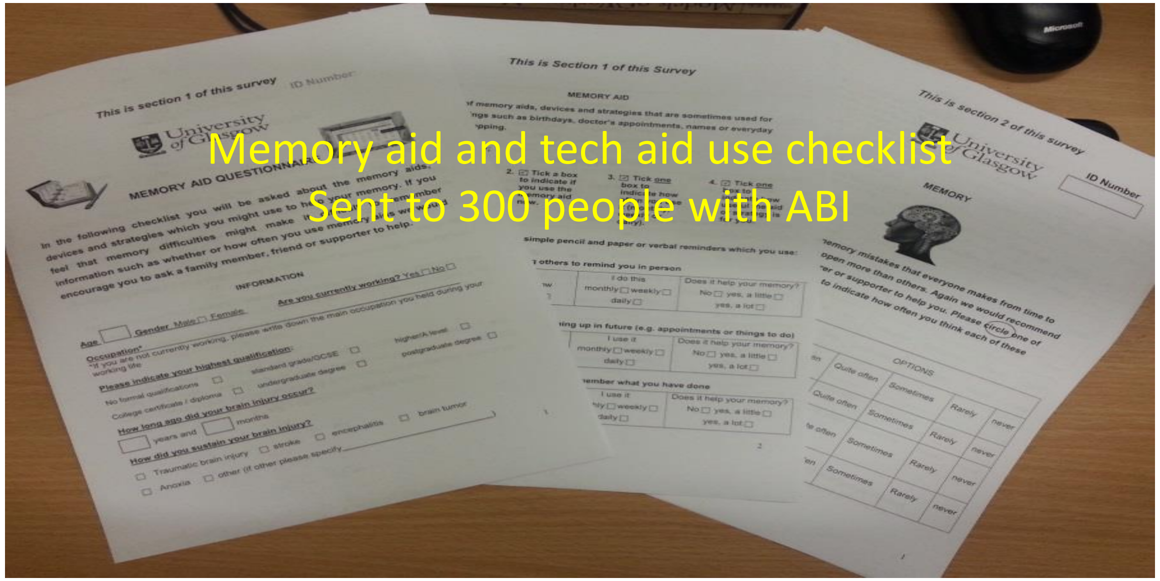
Diary

Age

Calendar

Use of technology prior to injury / onset

White board



Memory aid and tech aid use checklist

Sent to 300 people with ABI

**What tech, non-tech memory aids and strategies did we think people might use?**

**What factors did we think might predict memory aid use?**

Objective memory ability (ACE-R)

Repetitive practice

Employment

Leaving things in obvious places

Education

Using personal computers

Barriers to technology: cognitive, physical, practical, psychological

Text messaging

Alarm

Use of memory aid strategies (post and prior)

Notebook

Time since onset of injury / diagnosis

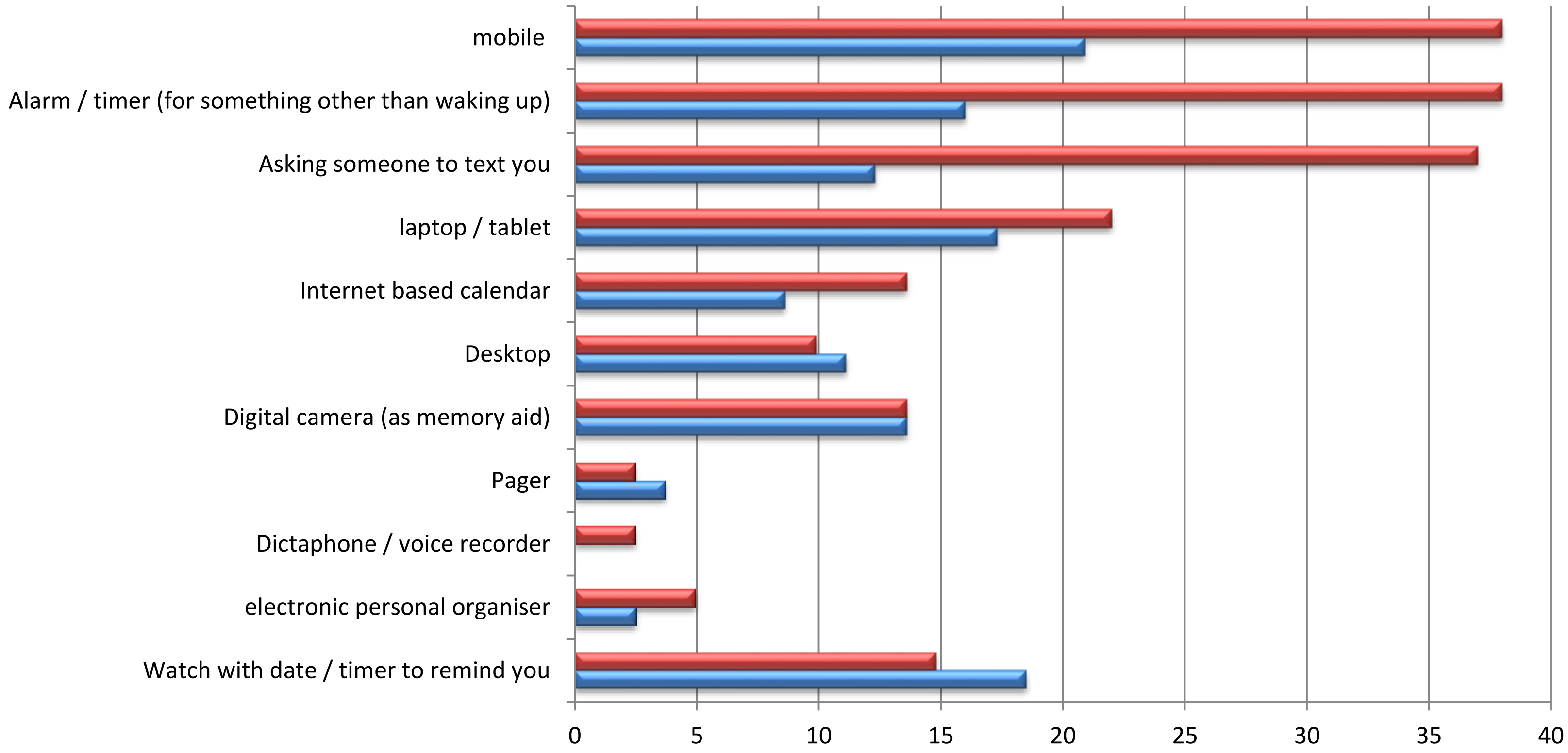
Asking others to remind

# Results

## Prevalence of tech use

ABI (n= 81) = **MODERATE USE** (38% use alarms, 38% use mobiles)

ABI tech use (%) – after ABI in red, before ABI in blue



# Survey conclusions

People with ABI are using *far more technology than ten years ago* – especially alarms, texting and mobile phone reminding (was around 8% in a previous study).

We found a self reported increase in use following an acquired brain injury

Tech memory aid use is best predicted by age (ABI group only), pre-morbid tech memory aid use (both groups) and amount of non-tech strategies and aids used (both groups)

The majority of the technology used by people with ABI was prompting technology.

# Survey results

PRMQ scores for 81 people with ABI surveyed in 2014 **1.5-2SDs higher** than general population – much lower self-reported prospective memory

**38% (n=81)** used mobile phone to remind them compared to
**81% (n=673)** of general population reported using digital reminders along with nondigital and interpersonal reminders (Sugden et al., 2019)

**So people with ABI have more need for prospective memory reminding technology but use them half as much**

# Reasons for low uptake - Sherer

Table 1

Factors associated with device non-use according to characteristics of the characteristics of the environment, person, and technology

| | Environment | Person | Technology |
|---|---|---|---|
| Non use | • Lack of a user-centered process for technology selection<br>• Little or no support for use from family/peers/employer<br>• Setting/environment discourages use or makes use difficult or uncomfortable<br>• Requires support that is not available<br>• Device choice made by someone else | • Unrealistic expectations of benefit<br>• Embarrassed or self-conscious about using device<br>• Resistant to help from technology<br>• Doesn't like a device's discipline<br>• Many changes in lifestyle with device use<br>• Lacks skills to use device and training not available | • Discomfort/strain in use<br>• Obtrusive and intrusive to use<br>• Is incompatible with the use of other devices<br>• Is too unwieldly, heavy<br>• Is complex and difficult to use<br>• Device is inefficient<br>• Repairs/service not timely or affordable<br>• Other and preferred options are available<br>• Doesn't trust technology |

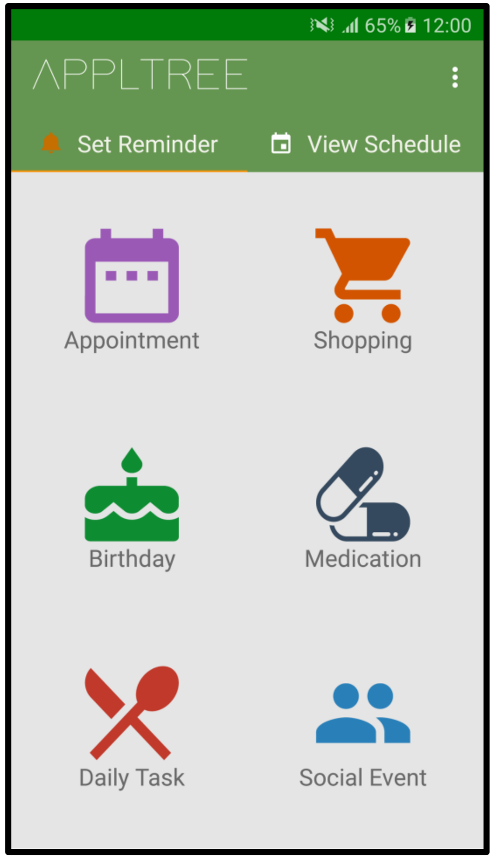
Source: Institute for Matching Person & Technology as adapted from Scherer (2005a).

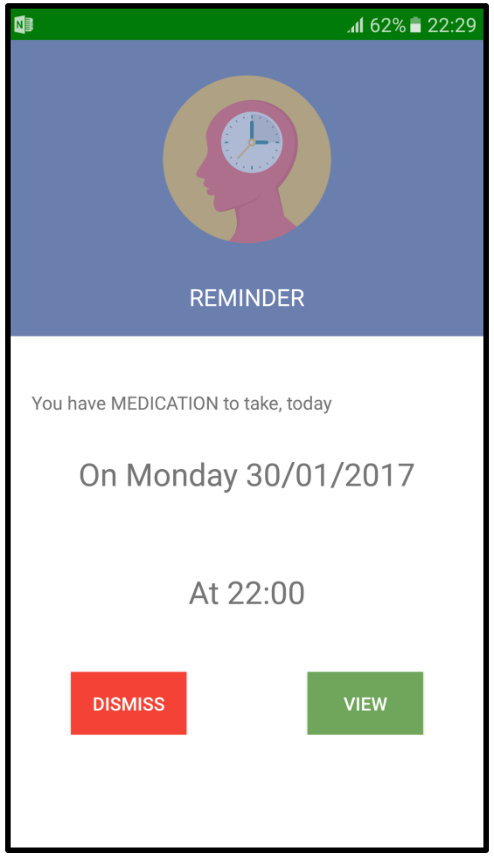
# ‘Total Circuits’ in ATC

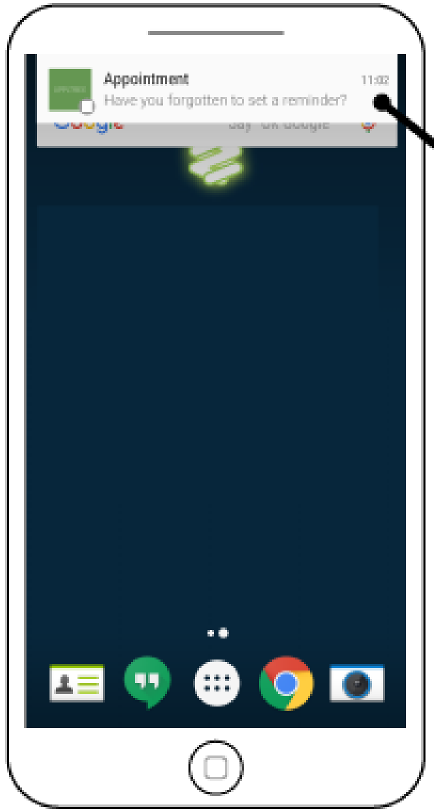
‘if you want to explain or understand anything in human behaviour, you are always dealing with total circuits.’

Bateson 1973, p. 465

# ‘Total Circuits’ model of smartphone reminder use



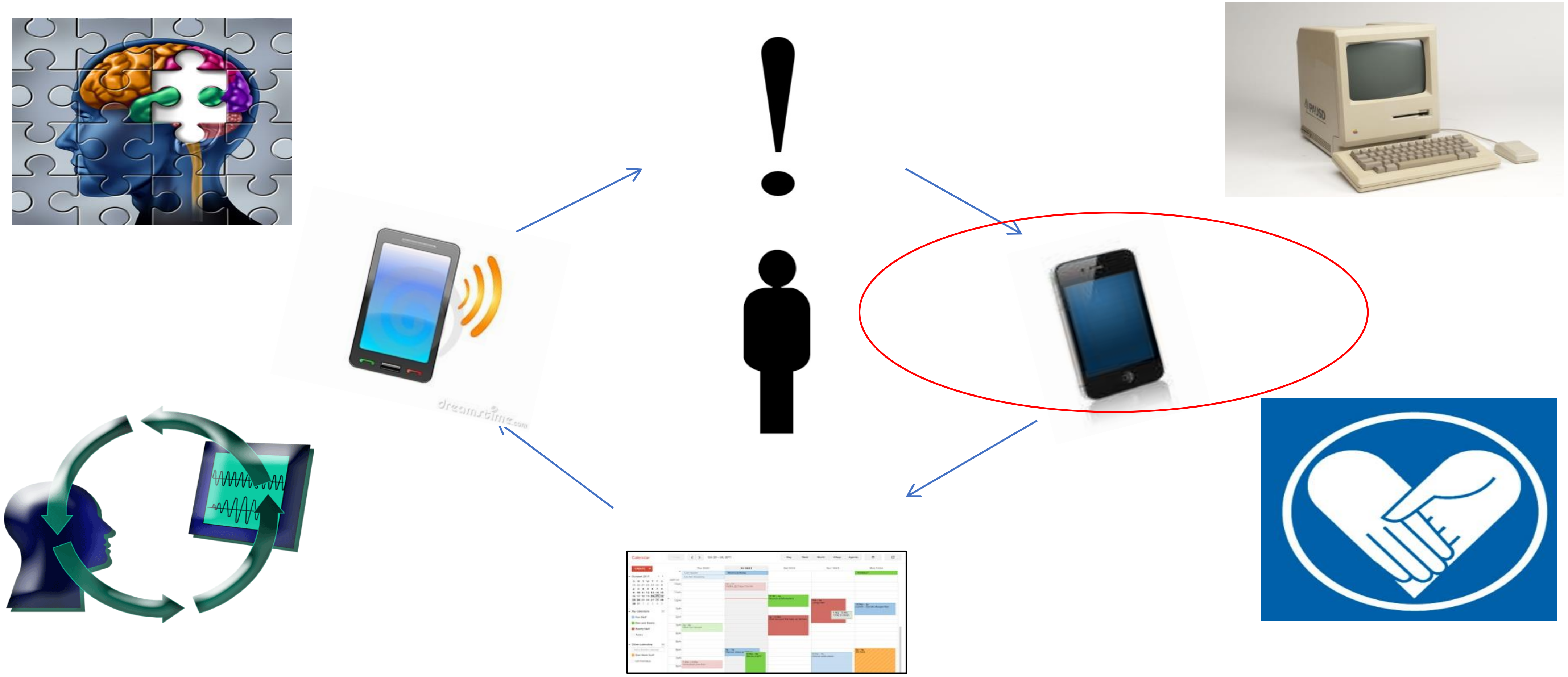



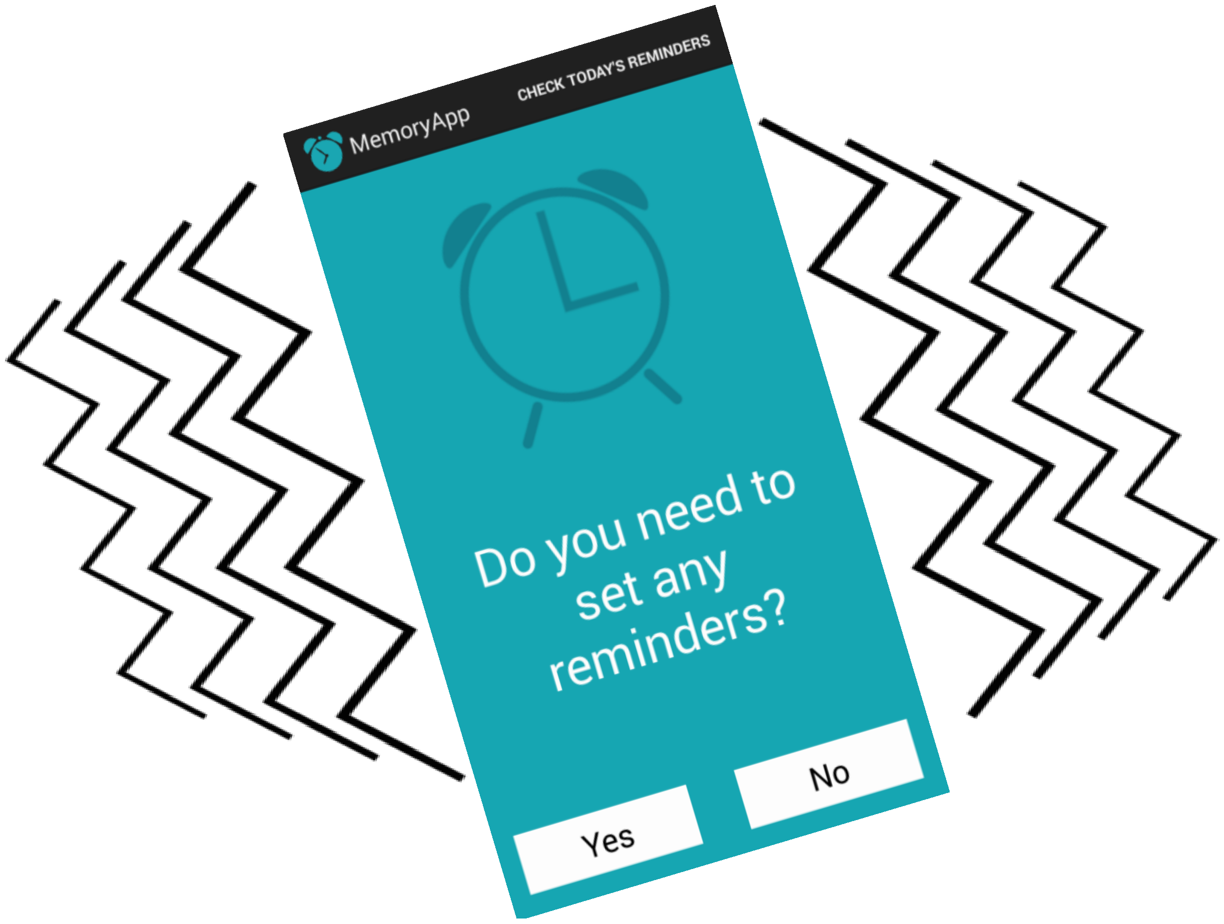

Prompt to set a reminder

# ApplTree

# ‘Total Circuits’ model of smartphone reminder use



# Unsolicited Prompting



# Background

**Insight and memory:**
'I forget I don't remember, then I remember I forget'

# Background

**Insight and memory:**
'It's just sometimes though he doesn't want to use it because he thinks he'll remember'

# Unsolicited Prompting

Notifications from the app which set off automatically throughout the day, prompting the user to set reminders

Issue of acceptability?

# Participants


- LE - 45 y/o difficulties with memory, planning and insight

  Did not have a phone

- KT - 37 y/o difficulties with memory, apathy, motivation

  Used a smartphone

- CD – 55 y/o disorganised thinking, short term memory difficulties and anxiety

  Owned a feature phone

# Context and Memory Tasks

**Caregivers**

- Nurses
- Physiotherapists
- Psychologists
- Neuropsychologists
- Occupational Therapists
- Speech and Language Therapists
- Support workers

BIRT
Brain Injury Rehabilitation Trust
The Disabilities Trust

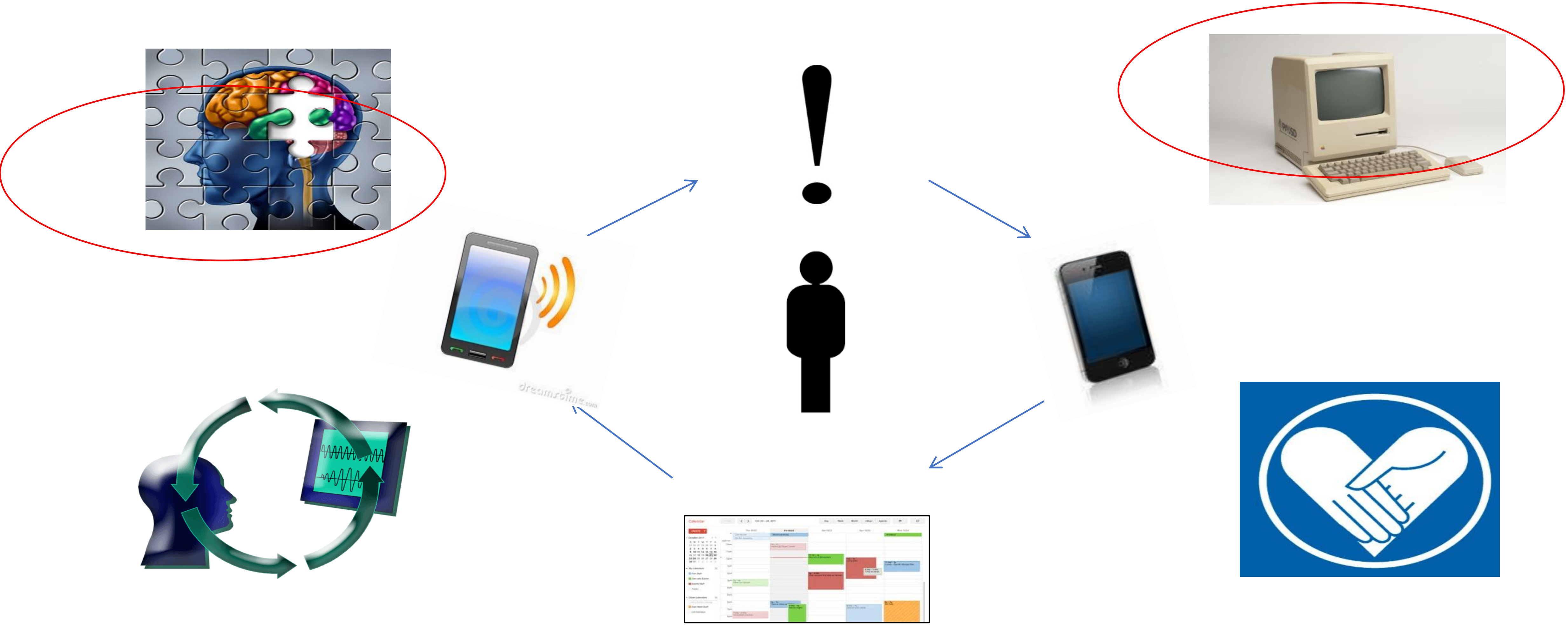
**PM tasks**

- Ask the nurse for medication
- Self care – apply creams after shower
- Remember to have breakfast before vocational outing
- Remember laundry
- Ask to use the computer
- Go to a rehabilitation session

# Results – UP impact

| Intervention Phase | Mean (SD) number of reminders set per day | | |
|---|---|---|---|
| | LE | KT | CD |
| With UPs | **2.5 (1.7)** | **1.7 (1.5)** | **6.3 (2.6)** |
| With UPs (fidelity checked) | 1.9 (1.1) | 1.2 (1.0) | 2.5 (1.3) |
| Without UPs | **0.7 (0.9)** | **0.1 (0.3)** | **2.5 (1.8)** |
| Without UPs (fidelity checked) | 0.7 (0.9) | 0.1 (0.3) | 1.2 (0.8) |

# ‘Total Circuits’ model of smartphone reminder use



# Field Notes

Perceived Need influencing app use and acceptance

*"Well I like my diary, I like keeping my diary 'cos I put everything in there" and, "…I write everything down. It's just… I don't really need that (points to phone) I write it all down". LE*

*"Eh… Well I don't really have a chance to forget because I've got a timetable. I've got various things that remind me and that". KT*

*Yeah I can see, I can see how handy it can be. In fact, I'll end up probably I need, that's my brain there, my thoughts" CD*

# Field Notes

Perceived Need and motivation influencing UP acceptance

*“Well they (the UPs) all say the same thing. Presumably you’d have to go and check the phone but eh… I don’t know I just always press no”. KT*

*“There’s never too many you know. If you need them, it’s just if you’ve got them and done it all – but it’s nothing against it you just don’t need it. I just press no. As you say just press no. Ah I’m just, it’s new to me so I’m amazed”. CD*

*“No my memory is fine. I get to stage when that goes 'beep' I think not again!” LE*

# Field Notes

Insight and support in the environment / motivation for tasks

***“right, so when it goes in my pocket that’s the alarm going off to tell me to take my medicine. But I don’t do medicine, it gets brought to me. So the alarms for the medicine is not really my problem. The staff give me my medicine. I can’t go… give me the meds!” LE***

***“There is just not enough going on here for me to have to remember anything to merit a device like that, you know”. KT***

# ‘Total Circuits’ model of smartphone reminder use

## Focus group quotes

**"… too busy a page for whatever you are looking at, puts people off."**

**"I don't think I would have the patience to go into it every morning'."**

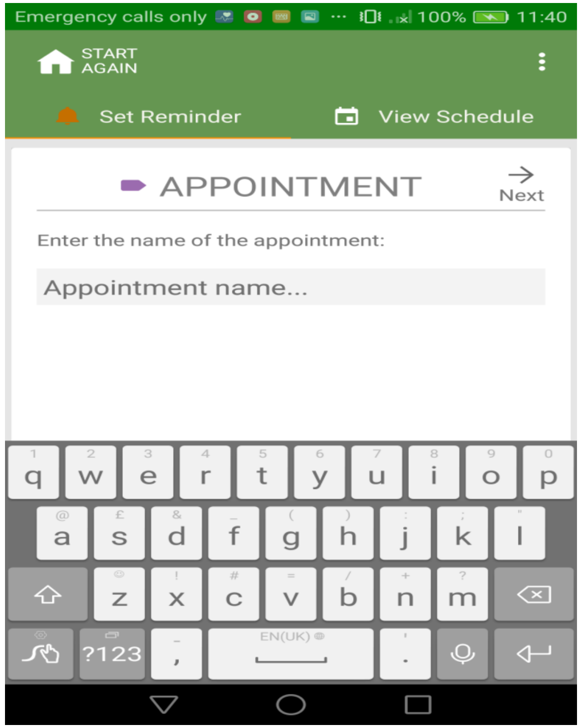
Can altering the design improve the quality of input into a smartphone reminder app for people with ABI?

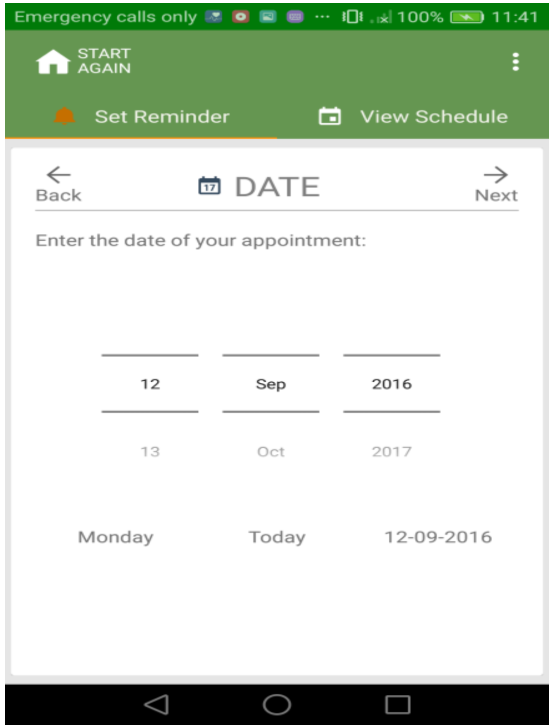
- List rather than calendar based
- Narrow / deep design structure
- All abstract symbols explained / fewer used

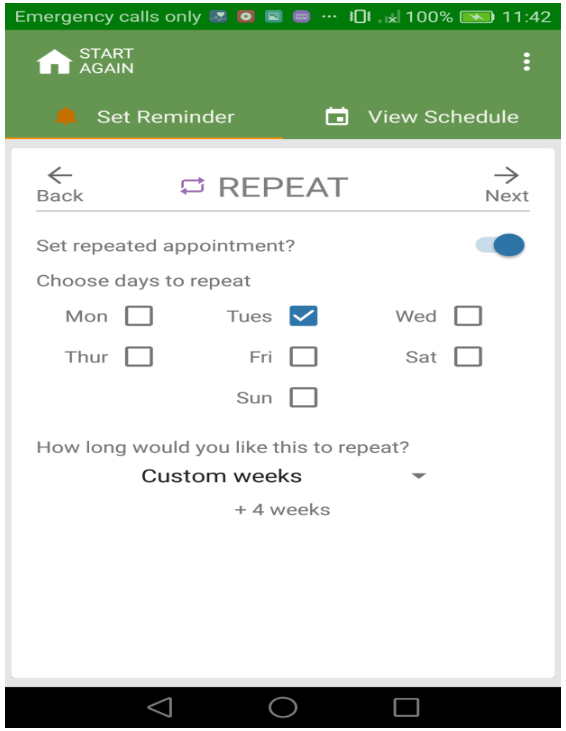
- Use clear and simple text
- Use consistent navigation and design on every page
- Use headings, titles, and prompts

# ApplTree project

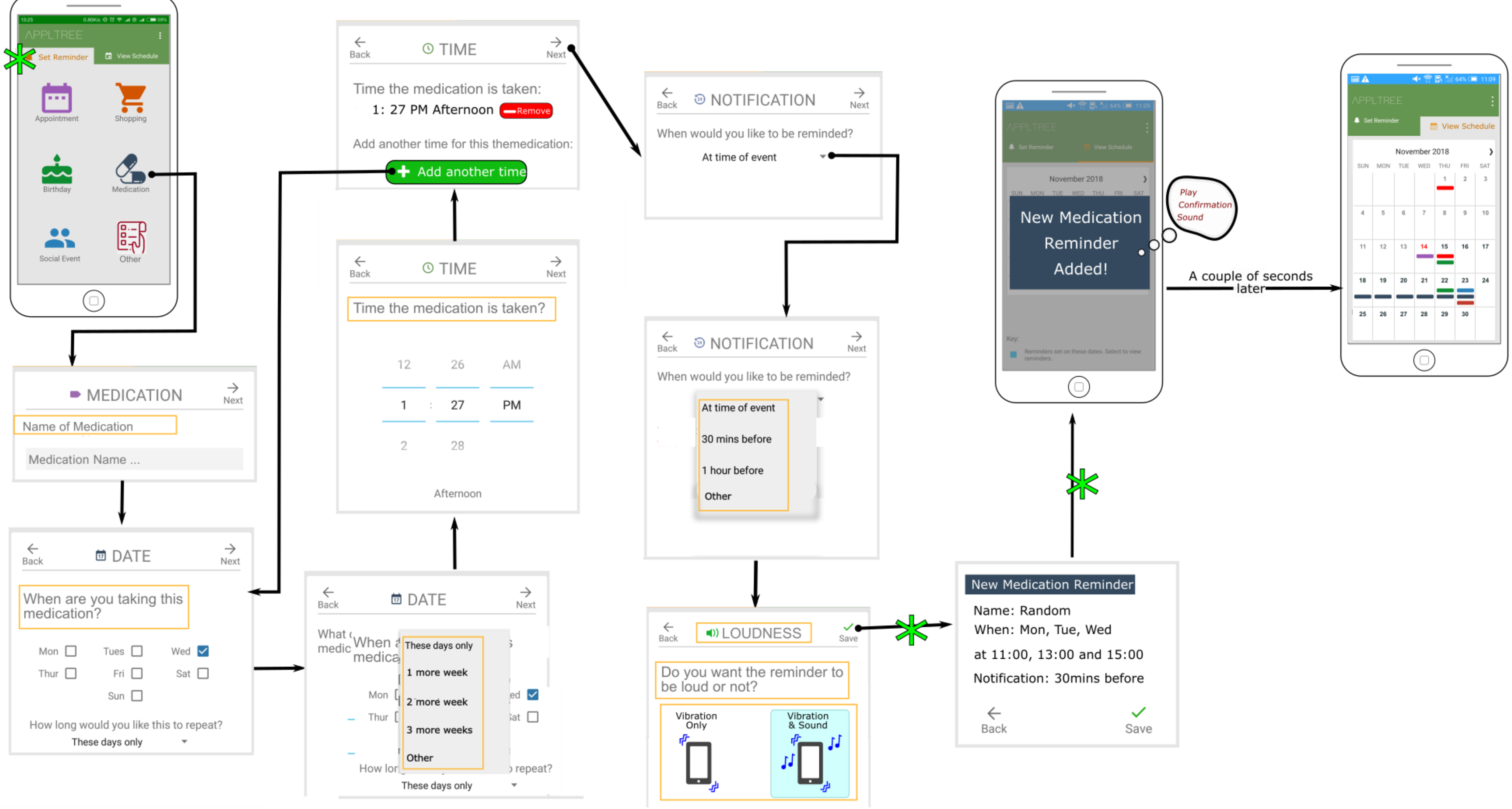
## Narrow / deep vs. Broad / shallow user interface

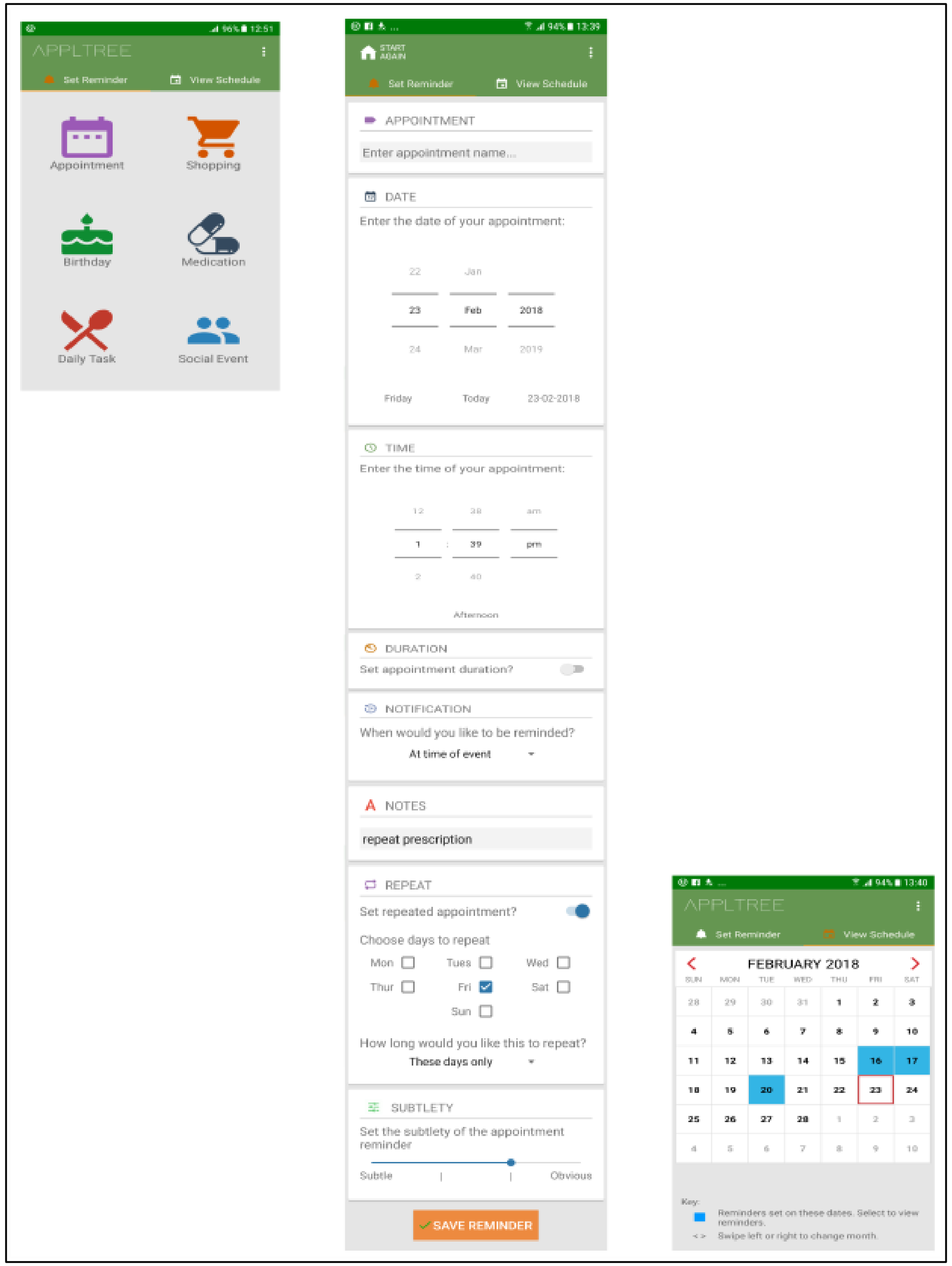


New Medication - Service User





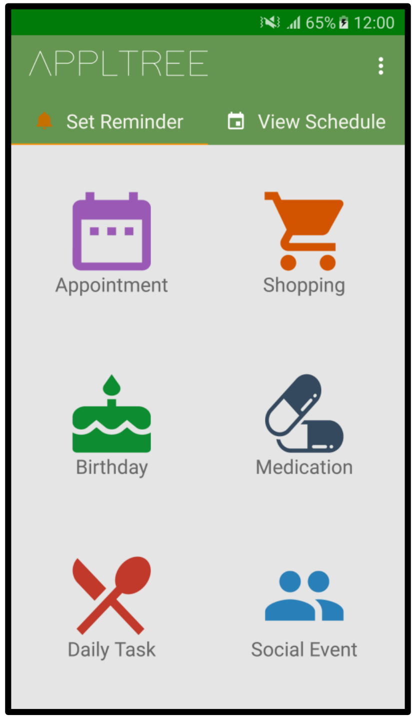

This is the design of every reminding app (I've seen)

# Study methods

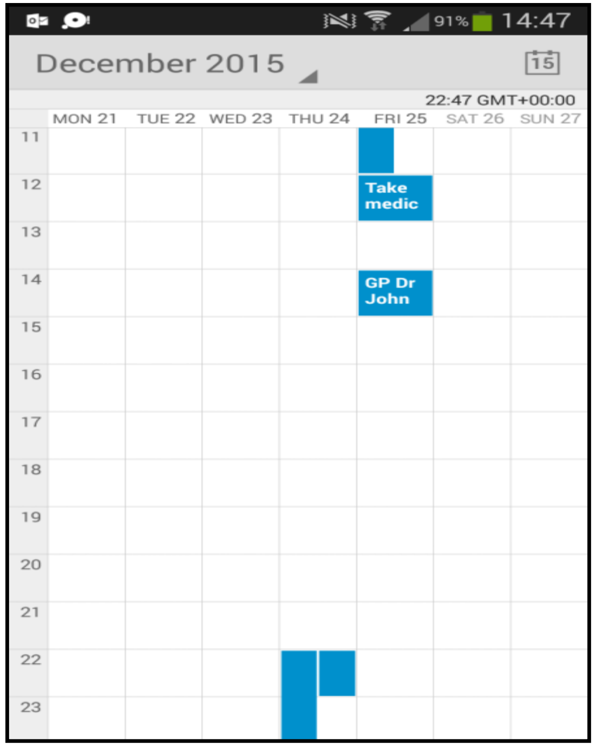
**N = 28 adults with ABI**

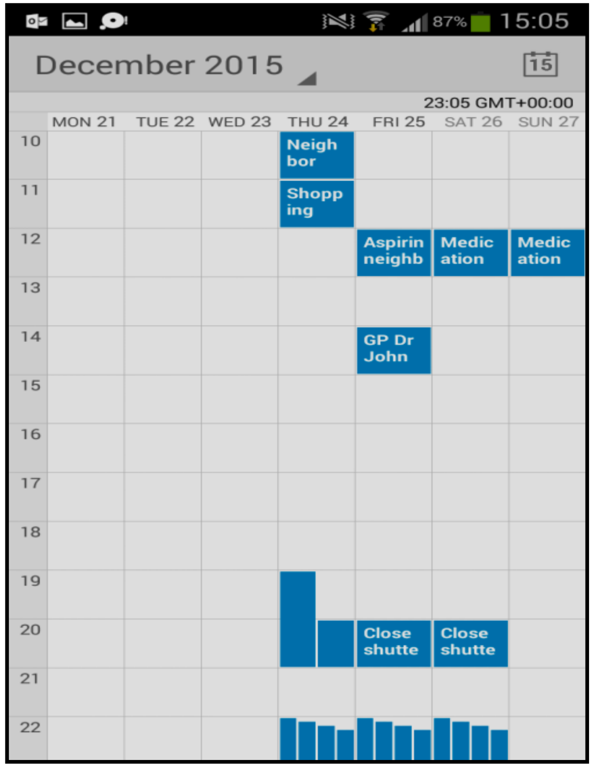
**Exploration of reminder app usability when setting example reminders**
*Tally of mistakes made, time taken and guidance needed*

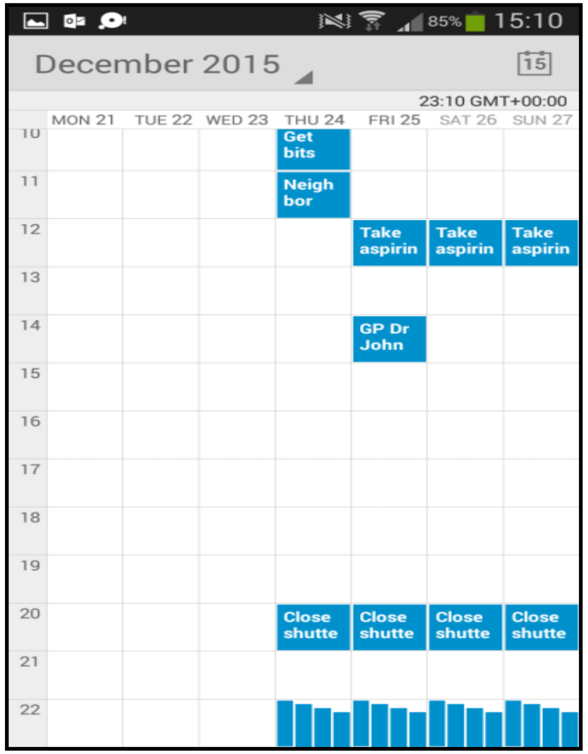
**Within subject comparison of two different app designs**
*Wilcoxon  signed-rank tests*



**With many errors** **Ideal 100% accuracy** **With few errors**



# Results

Preliminary analysis with 28 participants (13 male, average age 50.6, SD 12.02)

A significant decrease in average mistakes made when setting reminders when using a narrow/deep vs broad/shallow user interface

**Mean number of mistakes with narrow/deep = 2.32 (SD = 1.51) and mean number of mistakes with broad/shallow = 3.05 (SD = 1.9).**

A Wilcoxon Signed-Rank Test indicates that this difference is significant (mean difference = 0.73 mistakes per reminder, $W = 50$, $z = 3.187$, $p = 0.00142$).

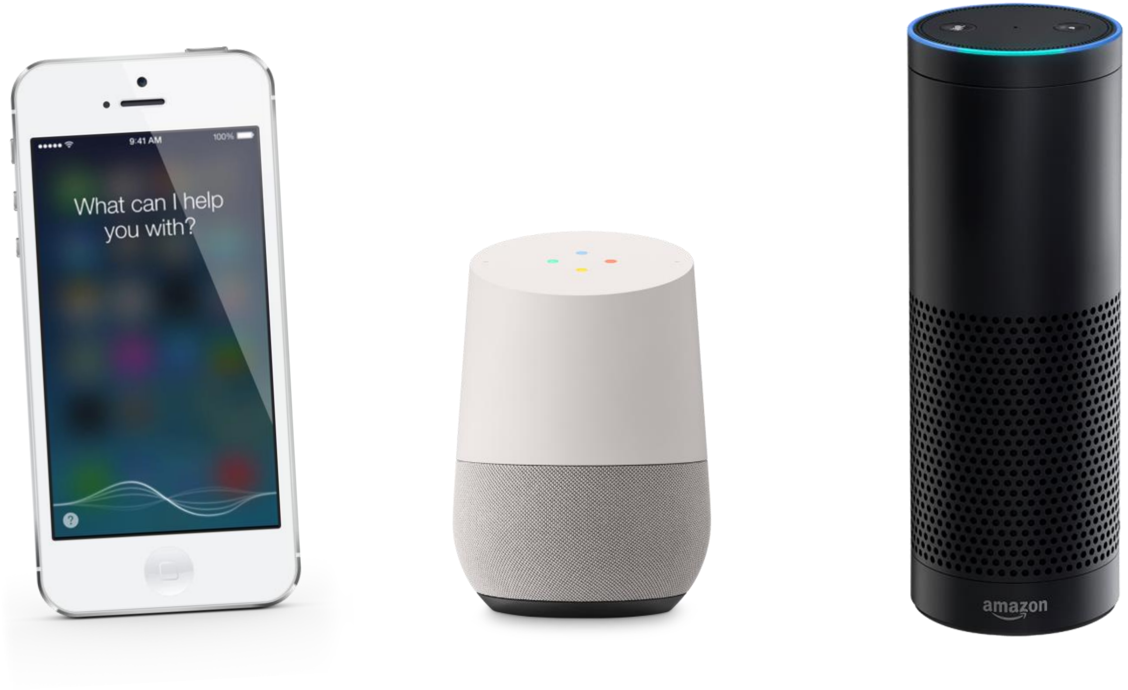
People asked for more guidance and took the same amount of time

# Future directions

# ‘Total Circuits’ model of smartphone reminder use

# Voice interfaces

- Voice Assistants (Voice-activated personal assistants)



# Methods

- Online Survey, people with ABI (n=112)
- Focus groups, people with ABI (n=23)
- Group interview, neuropsychologists (n=7)
- Online interviews with users of VAs (n=9)

# Results

- Low usage, high satisfaction (Survey: **8%** often, **23%** occasionally)
- Positive feedback
  - Reminders / prompting
  - Getting information online
- Concerns about lack of visual feedback & mobility

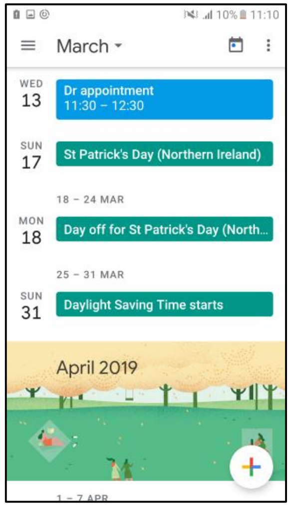
# Results

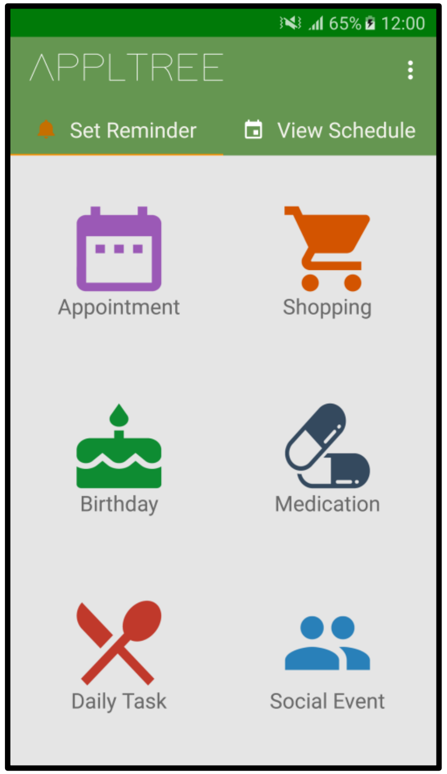
- Issues reported:
  - Not giving enough time for responding.
  - Trouble making VAs understand.
  - Difficulties understanding what the VAs are saying to the users.

# Results

- We can use them for:
  - Simple tasks
  - Prompting
  - Remote monitoring and assistance
  - Self-monitoring
- We shouldn't use them for:
  - Users with severe speech impairments
  - Conveying too much information
  - More complex tasks

# ‘Total Circuits’ model of smartphone reminder use

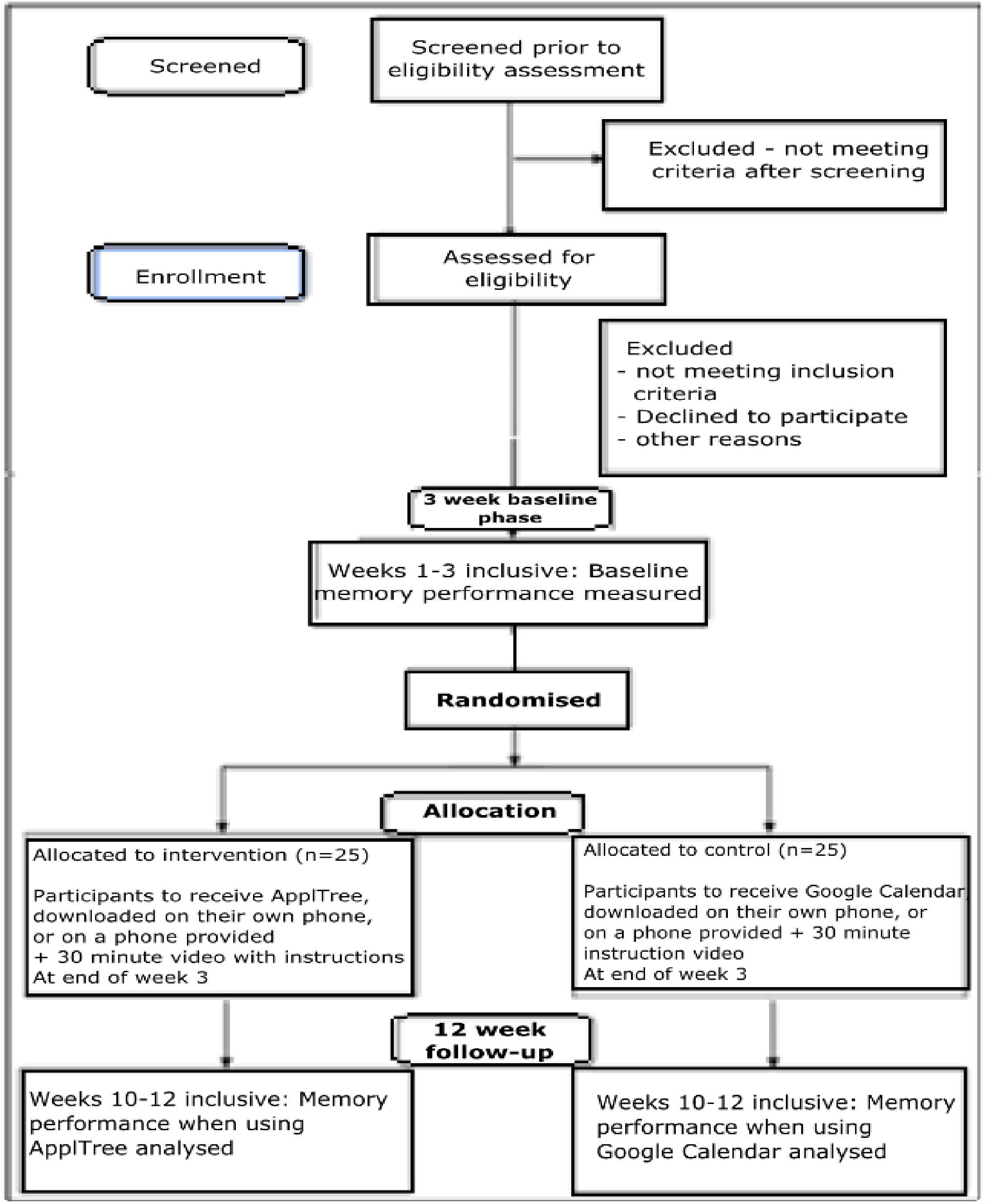



# AppReminders Trial

## Pilot Feasibility Trial of Mobile Reminding Apps

# Procedure



Screened
Screened prior to eligibility assessment
Excluded - not meeting criteria after screening
Enrollment
Assessed for eligibility
Excluded
- not meeting inclusion criteria
- Declined to participate
- other reasons
3 week baseline phase
Weeks 1-3 inclusive: Baseline memory performance measured
Randomised
Allocation
Allocated to intervention (n=25)
Participants to receive ApplTree, downloaded on their own phone, or on a phone provided
+ 30 minute video with instructions
At end of week 3
Allocated to control (n=25)
Participants to receive Google Calendar downloaded on their own phone, or on a phone provided + 30 minute instruction video
At end of week 3
12 week follow-up
Weeks 10-12 inclusive: Memory performance when using ApplTree analysed
Weeks 10-12 inclusive: Memory performance when using Google Calendar analysed

# Video Tutorial - Session

Laptop playing app tutorial video

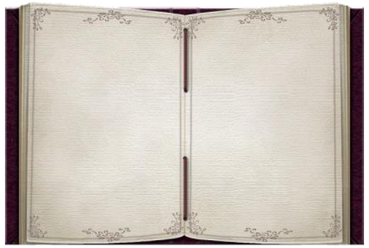
App setting assignments to ensure service user can use app

Service user

Service user’s smartphone

Clinician/rehab worker in supervisory role

# Outcome variables




n

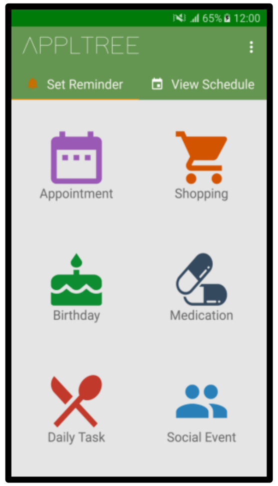
Memory logs and text times to
measure memory performance

Numbers recruited, and how many
kept coming to study sessions and used
the app until the end of the trial

Feedback from those involved to
understand how
To implement this type of intervention

# Hypotheses

(1)Recruitment (randomisation) of at least 80% of planned sample size
(2)70% retention of randomised sample to follow up (wk10-12) for both study arms;
(3)70% of participants in each arm with at least one reminder per week set during follow up.

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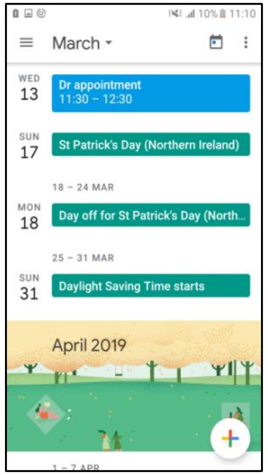



ApplTree vs Google Calendar for improving memory performance

Feedback about how to deliver this intervention in practice

What technical support is needed?

# Next Steps

- Full trial if indicated
- Incorporating steps to overcome issues in practice
- Future collaborations to bring innovative assistive technologies into community rehabilitation

# Summary

PM tech is:

**Needed** (significantly lower prospective memory functioning)

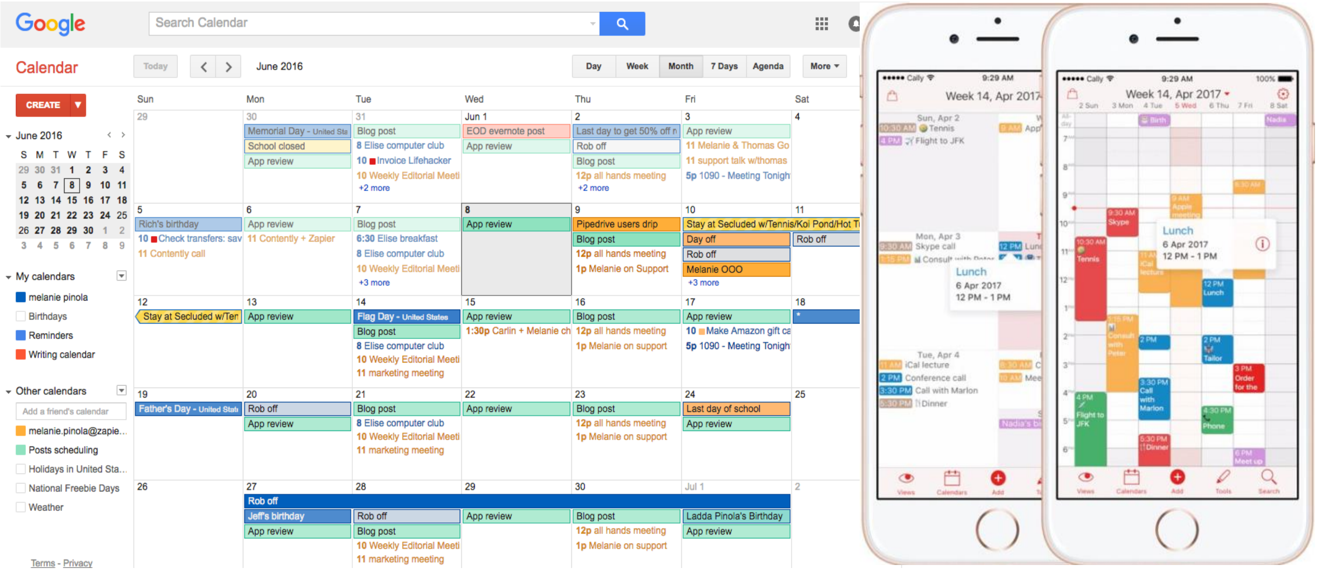
It **works** (There is good evidence prompting technology is effective)

but is **under used** (People with ABI use it half as much as general pop)

# Summary

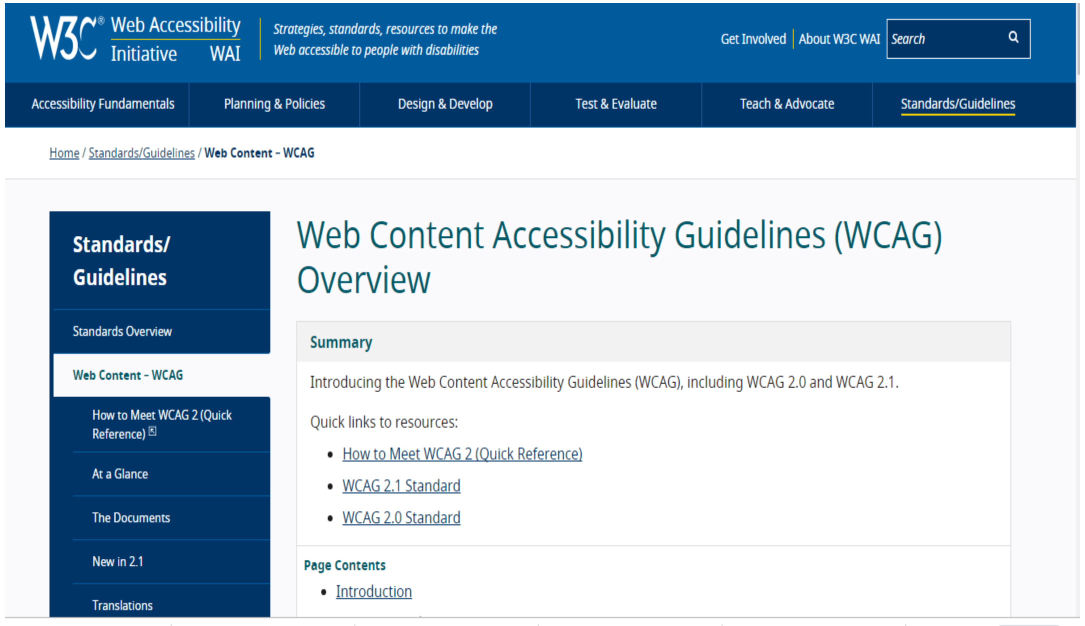
User and UI needs may be different – we can’t assume off-the-shelf technology will be fit for purpose

“… too busy a page for whatever you are looking at, puts people off.”



# Summary

We need to collaborate to create and utilise the right technologies

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the brain injury association

swarm
ONLINE

NHS
Greater Glasgow and Clyde

MRC Medical Research Council

CHIEF SCIENTIST OFFICE