

Mobile phones and Cognition in Children

Report on studies by Alan W. Preece and Christian
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Starting points

Assumption:

- Effects have been identified in adults
- Effect in Children may be greater
 - Children may be a sensitive subset of human (measles for example is mild in adults, serious in children)
 - In the past: ethic concerns about research with children
 - ...

First media awareness:

- Statement of the **I**ndependent **E**xpert **G**roup on **M**obile **P**hones: Mobile Phones and Health , 2000, (The Stewart Report)



Reasons for such research

- Concerns of public in general
 - Lack of existing knowledge, no known studies on children
 - Children are Power-User!
 - 88% of children 11 – 15 y.o. own a phone
 - 66% in possession for > 1 year
 - 10% had used > 45 mins of calls per day
- Pupil researcher Initiative (Sheffield Hallam University)



Concerns of public in general

- **Dielectric properties of the brain**
(higher water content – both ϵ' and ϵ'' are higher therefore the initial SAR will be higher)
- **Less muscle, skin and bone between phone and brain**
- **Young tissues are more susceptible?**
(Cf. ionising radiation)
- **More years to collect and suffer detriment**
- **development**
(functional and physiological development of head/brain not at the same level as adults, therefore e.g. conductivity might be different)
- **long term effects**
(children of today will be exposed to mobile phones for a longer period of time over life-span than previous generations)



Comparison of proportions



An 11-year old is almost exactly intermediate

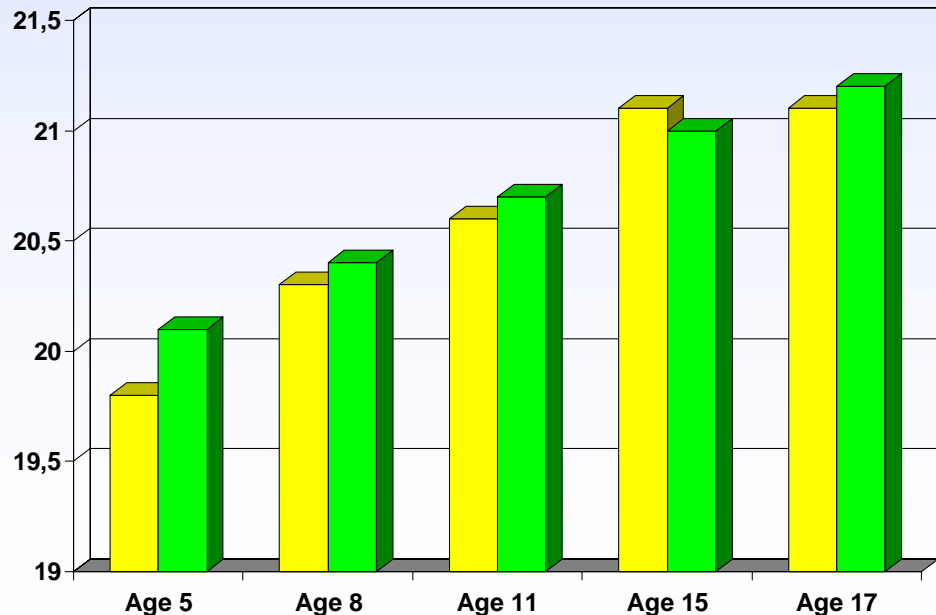


Concerns of size under the loupe

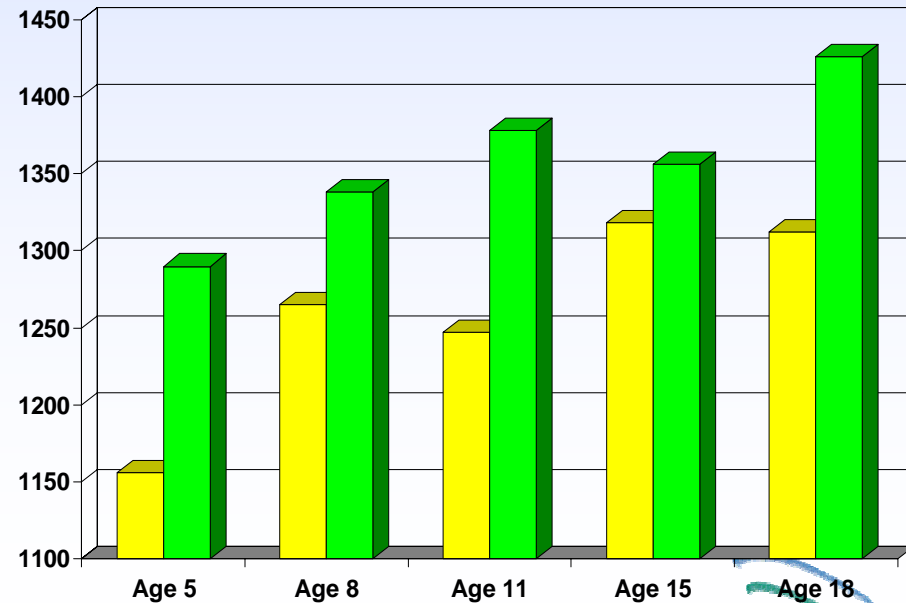
- Assumption: Children are more vulnerable than adults to EMF emitted by mobile phones due to differences in head geometry – children have smaller heads

Head circumference (cm)

Girls Boys



Brain weight (g)



What health effects should research consider?

- Harmful effects – short term, long term
- Other effects – i.e. within a physiological range

Health

- Cancer
- Ageing
- Neuro-degeneration
- Stress
- Epilepsy
- High temperature

or

Physiological

- Cognition*
- Behaviour*
- Blood flow*
- Blood pressure*
- Evoked potentials
- Mild temperature

*within physiological ranges



Human cognitive studies (1)

- 1. Preece AW, Iwi G, Davies-Smith A, Wesnes K, Butler S, Lim E, Varey A.
Effect of a 915-MHz simulated mobile phone signal on cognitive function in man
Int J Radiat Biol. 1999 Apr;75(4):447-56.
- 2. Koivisto M, Revonsuo A, Krause C, Haarala C, Sillanmaki L, Laine M, Hamalainen H.
Effects of 902 MHz electromagnetic field emitted by cellular telephones on response times in humans
Neuroreport 2000 Feb 7;11(2):413-5
- 3. Krause CM, Sillanmaki L, Koivisto M, Haggqvist A, Saarela C, Revonsuo A, Laine M, Hamalainen H.
Effects of electromagnetic field emitted by cellular phones on the EEG during a memory task
Neuroreport 2000 Mar 20;11(4):761-4.



Human cognitive studies (2)

- 4. Koivisto M, Krause CM, Revonsuo A, Laine M, Hamalainen H.
The effects of electromagnetic field emitted by GSM phones on working memory
Neuroreport 2000 Jun 5;11(8):1641-3.
- 5. Lee T.M.C. *et al* 2001
Effect on human attention of exposure to EM fields emitted by mobile phones
Neuroreport (12) 729-731
- 6. Lass J *et al* 2001
EMF effects on attention and memory
EBEA (5) 97-98
- 7. Edelsteyn & Oldershaw 2002
The acute effects of exposure to the EM fields emitted by mobile phones on human attention
Neuroreport 13 119-121



A brief literature review on EMF & cognitive functions (behavioural)

Study	Result(s)
Preece et al., 1999	↓ reaction time (1/15)
Koivisto et al., 2000a	↓ reaction time (1/14)
Koivisto et al., 2000b	↓ reaction time (1/4)
Lee et al., 2001	↓ reaction time (2/4) (b/w S's design; Bonferroni?)
Edelstyn & Oldershaw, 2002	Improved performance (5/6) (b/w-S's design; phone position; Bonferroni?)
Haarala et al., 2003	No effect
Lee et al., 2003	↓ reaction time (1/4) (Bonferroni?)
Smythe & Costall, 2002	improved memory but only in men 1/2



Results from the seven studies

- Speeding up in Simple reaction time
- Speeding of vigilance response
- Effect enhanced by “workload”
- Improvement in accuracy (except one study)
- Effect appears to persist after exposure (users are “smarter” than non-users)
 - Keetley
 - Lee *et al*
 - Bristol study

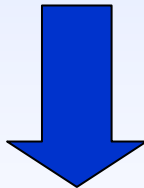


Experiments in Children?

How to proceed?

Are ethic aspects against this?

Having the same testing methods?



Presentation of two different independent studies
carried out by **A. Preece** and **C. Haarala**



Power deposition levels from phones

- Highest brain SAR from GSM (0.25 W) = 0.44 W/kg
- Lowest SAR from GSM model = 0.02 W/kg
- Range of SAR from analogue = 0.9 - 1.76 W/kg

Thermal estimates

Worst case for head:

4 W/kg for 30 min = 1.7°

Worst case for brain:

0.44 W/kg for 30 min - 0.2° (GSM)

1.6 W/kg for 30 min - 0.7° (Analogue)

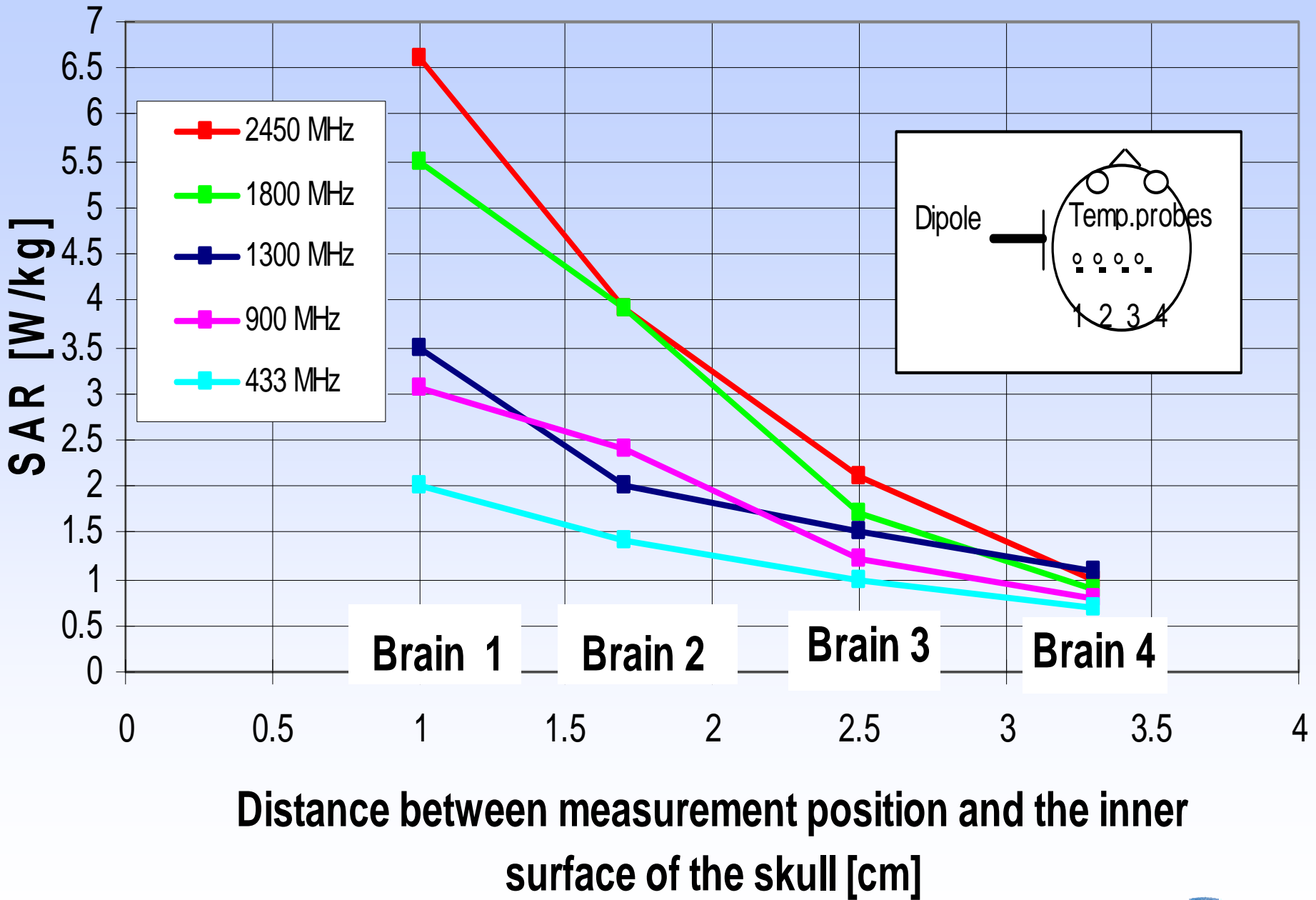
Measured or estimated (for GSM)

Anderson and Joyner ('95) 0.03°

Van Leeuwen (,99) 0.11° (time constant 6 min)

Wainwright ('00) 0.1°

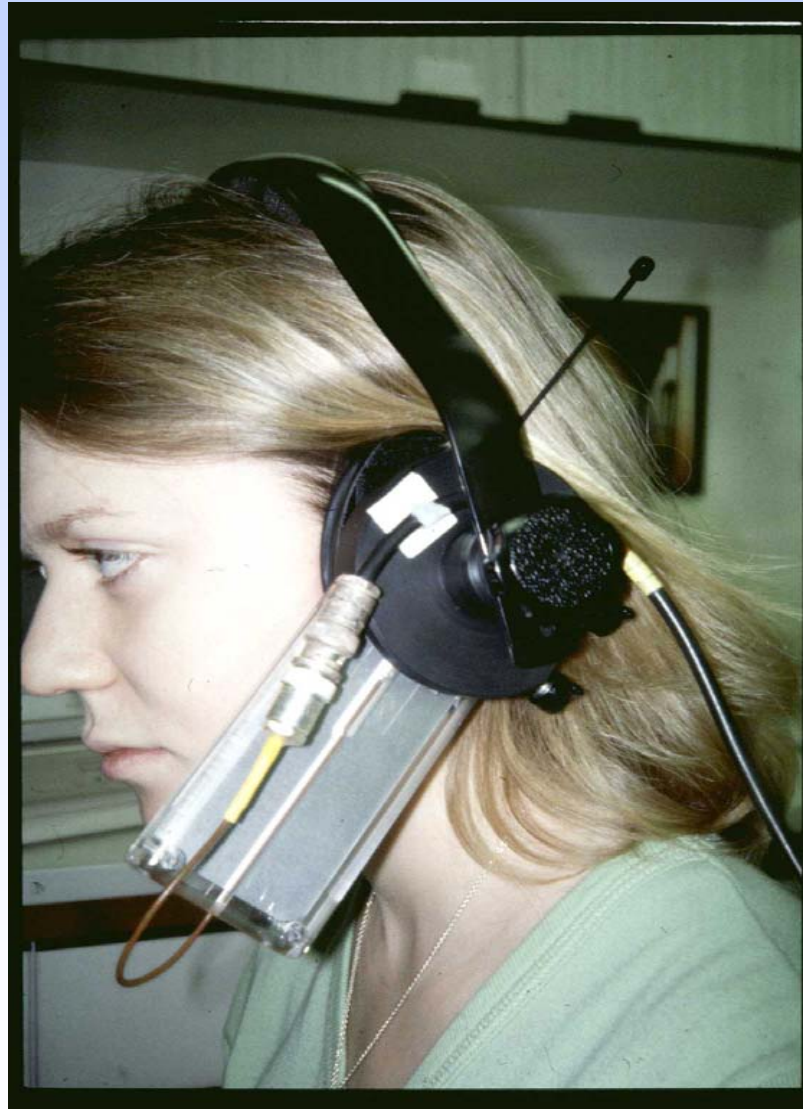




Set-up of the Bristol Experiment as Example



Used Equipment in Bristol experiment



Human cognitive function tests (Bristol experiments)

Standard tests used to assess effects of drugs e.g. opiates, psychotropics for medico-legal purposes (Cognitive Drug Research, Ltd.)

1. Immediate Word Recall
2. Picture Presentation
3. Simple Reaction Time
4. Digit Vigilance Task
5. Choice Reaction Time
6. Spatial Working Memory
7. Numeric Working Memory
8. Delayed Word Recall
9. Delayed Word Recognition
10. Delayed Picture Recognition

10 specific tasks

15 derived parameters (speed and accuracy)



Preece: Subjects of Bristol Test

- **Hospital staff (18)**
 - Age range 21-49
 - Mean age 31.4 years
 - 9 male/9 female
 - Mean phone use **53.4** min/month
- **Medical students (18)**
 - Age range 20-24
 - Mean age 21.7 years
 - 9 male/9 female
 - Mean phone use **372** min/month (one outlier)

Tea, coffee, alcohol, sleep, medicines monitored



Comparison of the two independent studies

	Haarala et al.	Preece et al.
Subjects	10-14 year olds	10-12 year olds
n	32 (16 boys)	18 (9 boys)
Exposure	Nokia 6110 with speaker removed	Nokia 3110 with speaker removed
SAR	1.44 W/Kg (1g)	Near the top of the range of commonly available phones
Mounting	The phone in an acrylic cradle mounted on a plastic ear defender, replacing the earmuff on the left side.	



Two independent studies

	Haarala et al.	Preece et al.
Design	Off vs. On (0.25 W), double-blind, within-subject	Off vs. 0.025 W vs. 0.25 W, double-blind, within-subject
Exposure time	40-50 min	30-35 min
Testing sessions	Sequential days (24 +/- 1 hr)	Sequential days, ~same time of the day

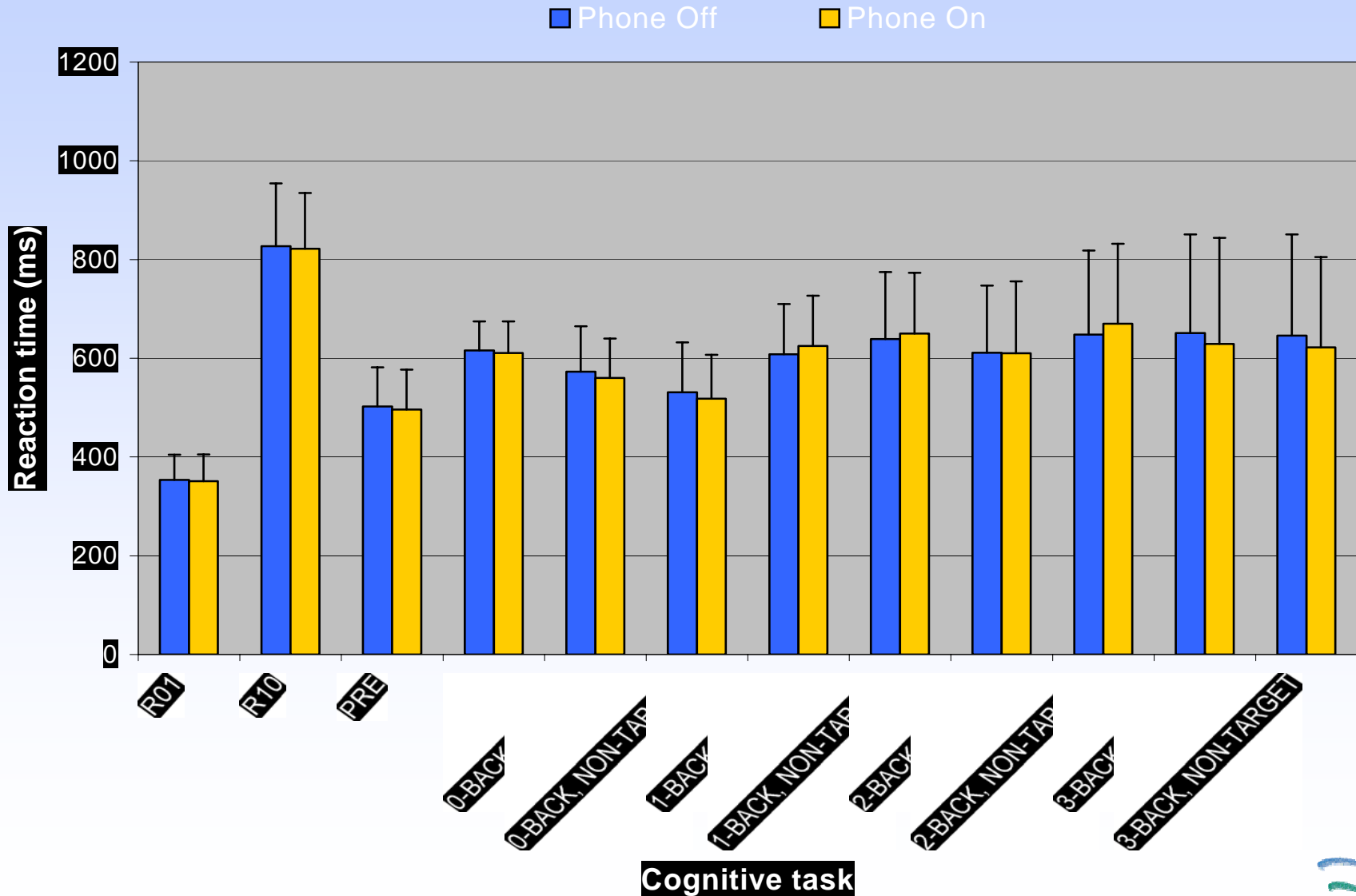


Two independent studies

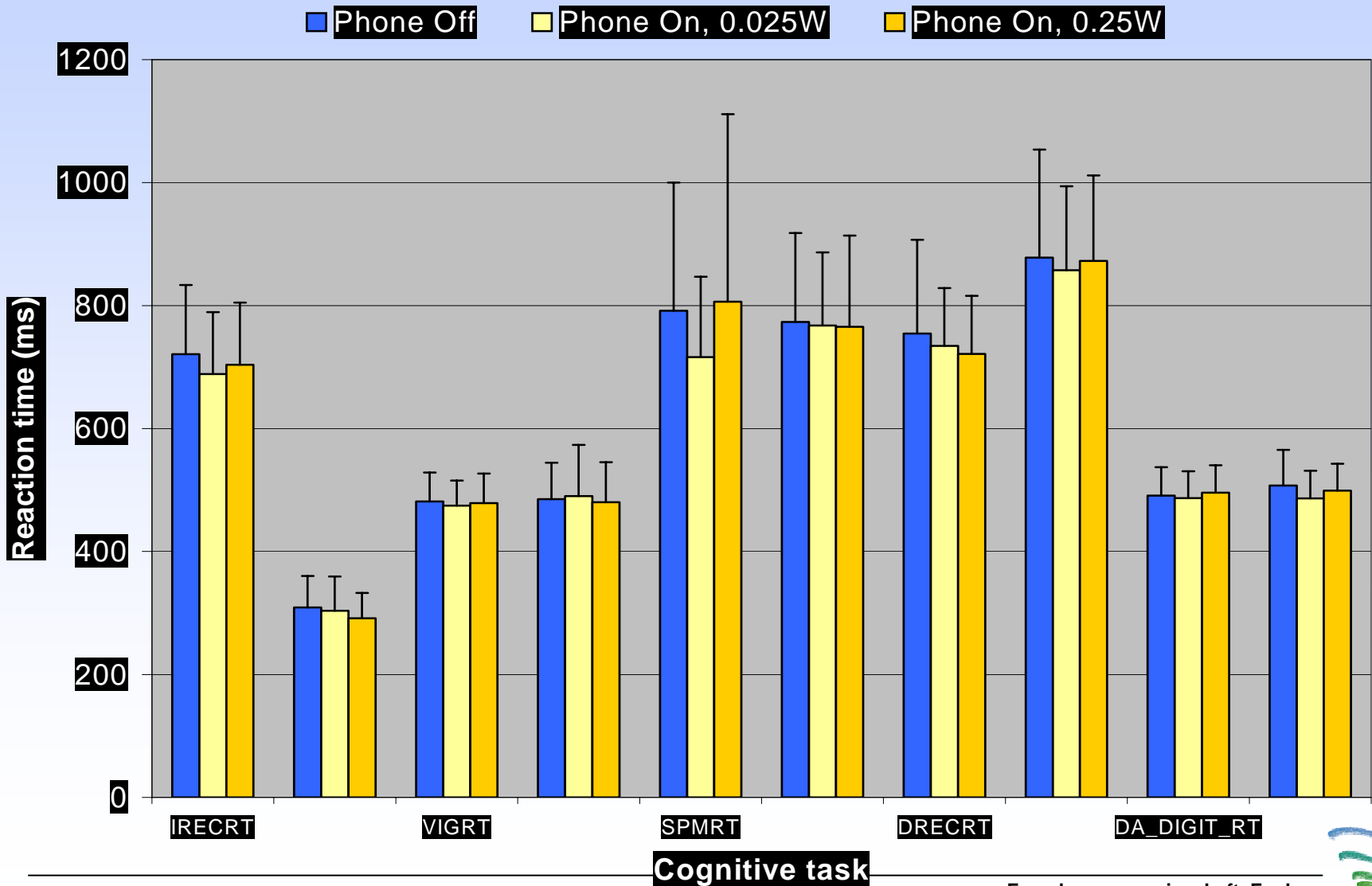
	Haarala et al.	Preece et al.
Cognitive tests	<p>CogniSpeed</p> <ul style="list-style-type: none">Simple reaction time2-choice reaction time10-choice reaction timeVigilance task <p>N-back</p> <ul style="list-style-type: none">0-back1-back2-back3-back	<p>Cognitive Drug Research</p> <ul style="list-style-type: none">Word recognition ISimple reaction timeNumber vigilanceChoice reaction timeSpatial memorymemory scanningWord recognition IIPicture recognitionDual attention task



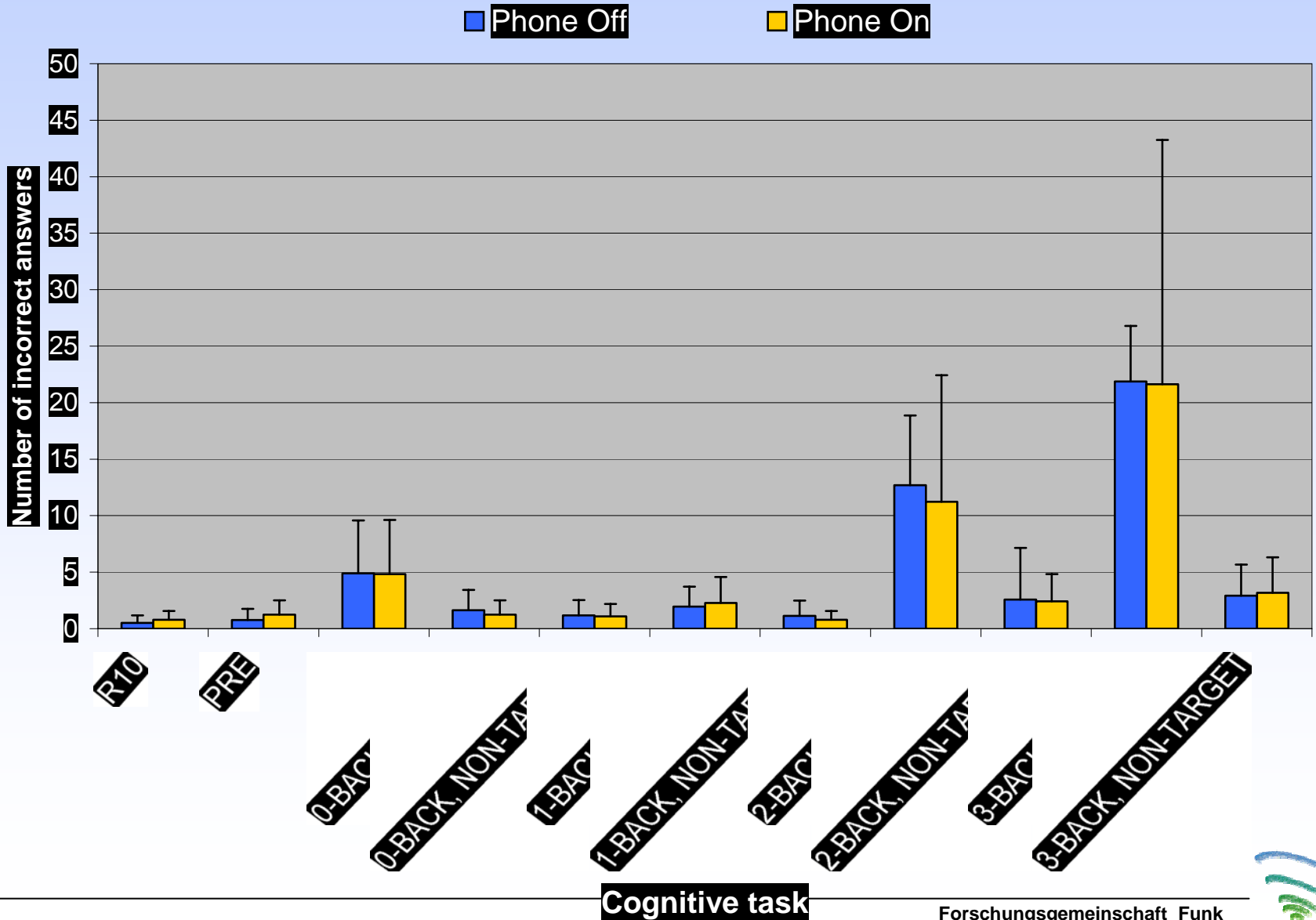
Reaction times, Haarala et al.



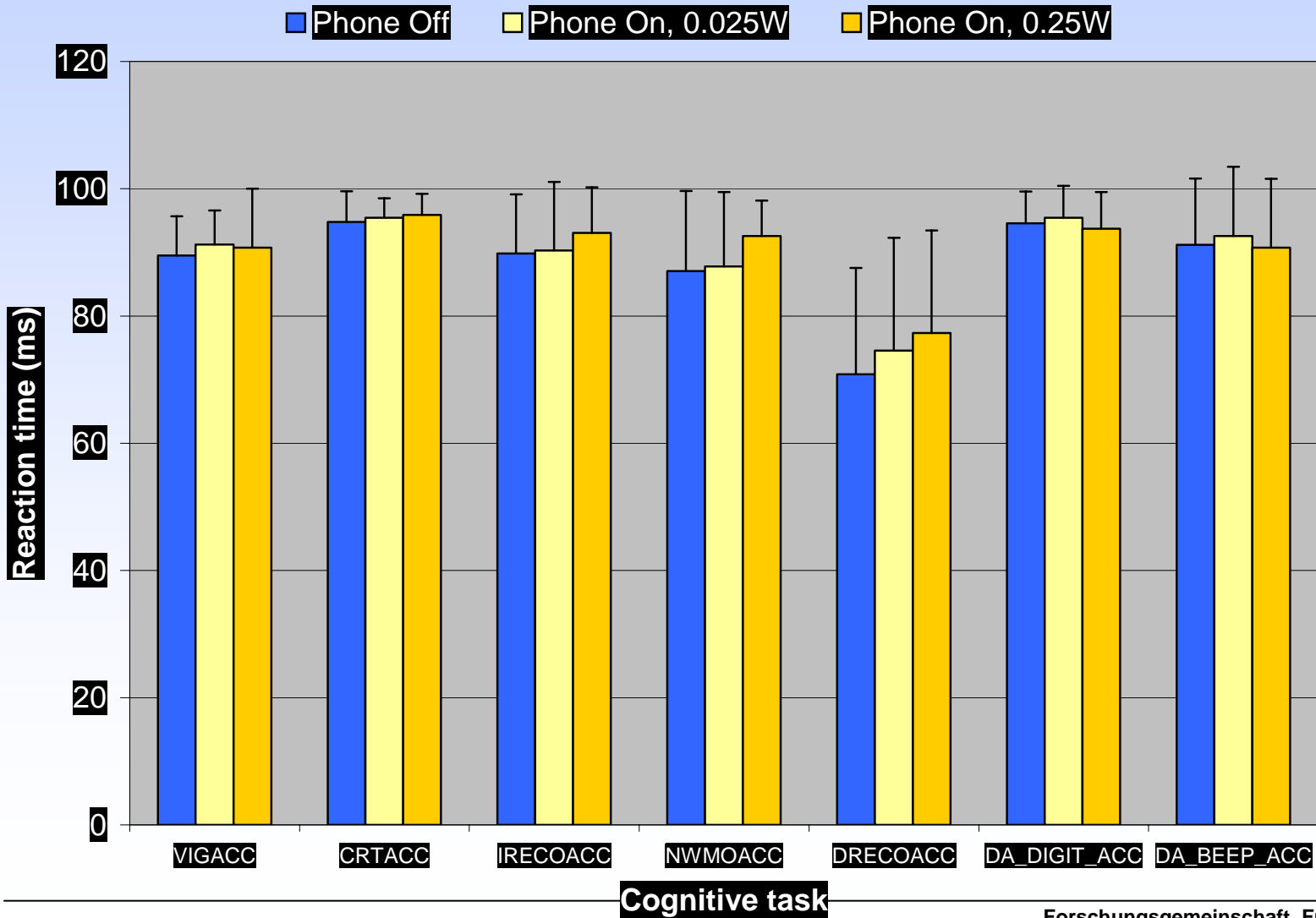
Reaction times, Preece et al.



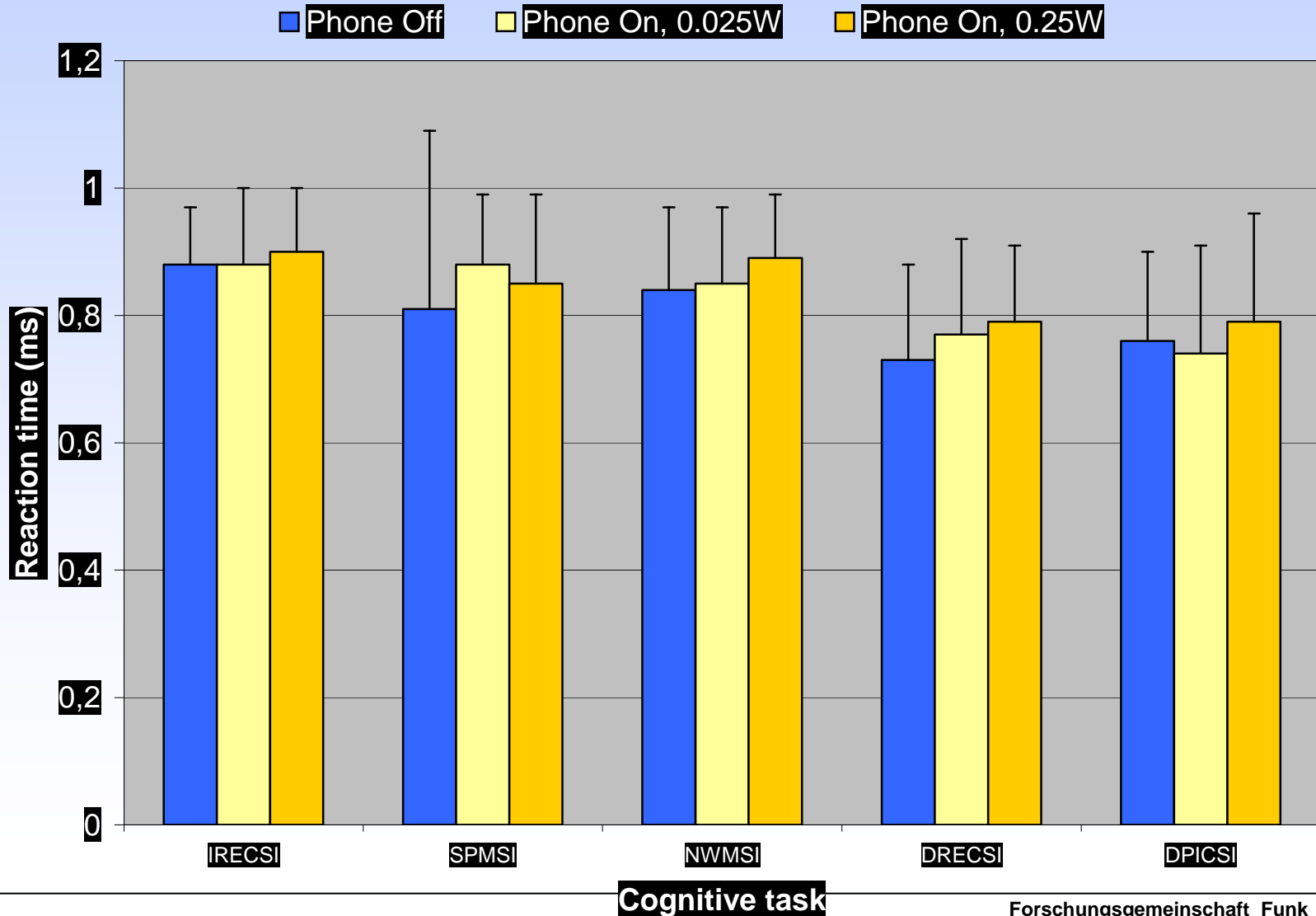
Accuracy, Haarala et al.



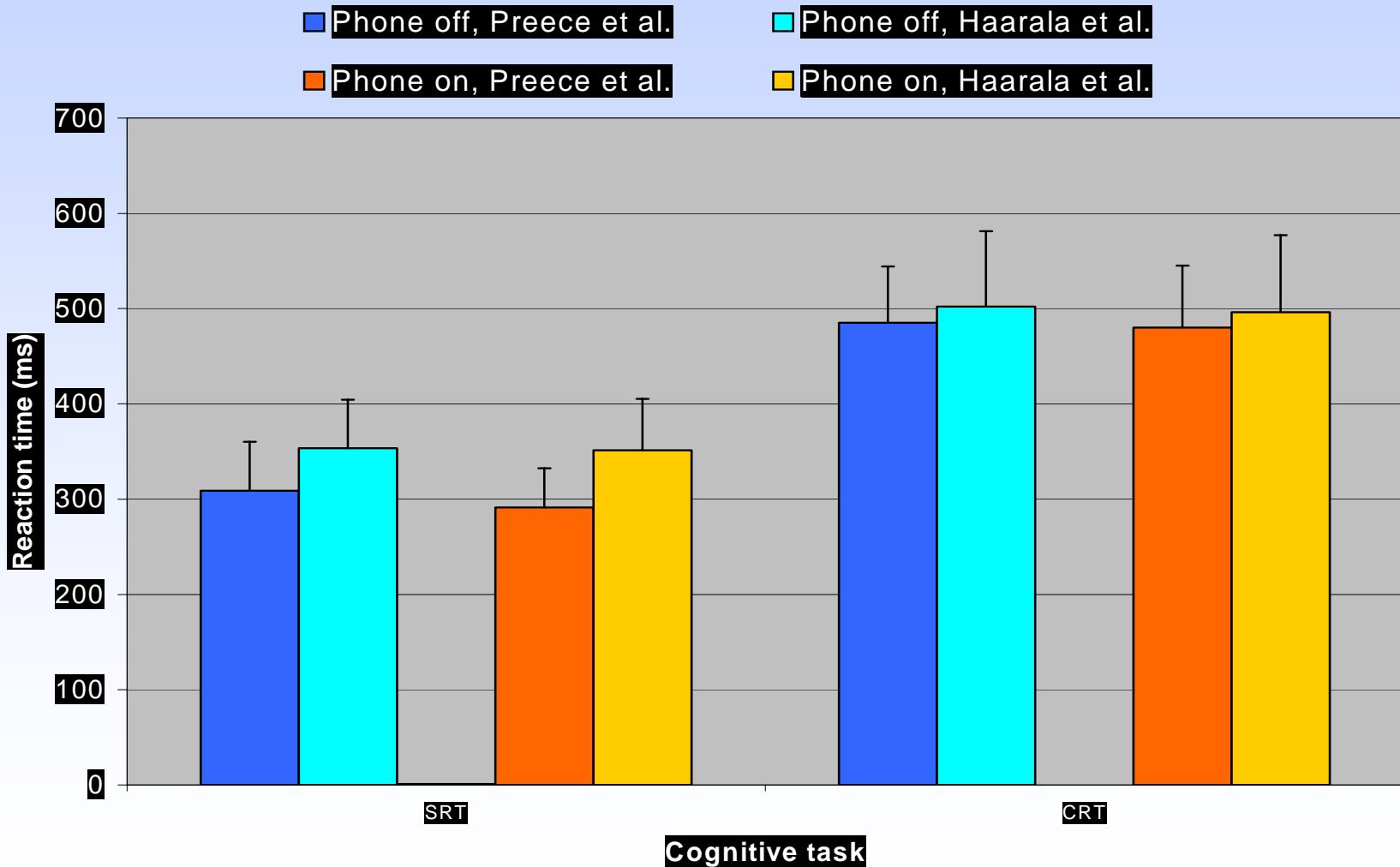
Accuracy, Preece et al.



Indices, Preece et al.



Two comparable tasks* in the present studies



*SRT in Preece et al. had the word 'yes' as a stimulus, and number '0' in Haarala et al.



Results out of the experiments

- There were no significant differences between sham, 0.025 W, and 0.25W exposures in either study.
- Mobile phone did not affect the children's cognitive performance as measured by response speed and accuracy.
- The discrepancy in results of existing literature may be due to methodological differences (design, exposure set-up):
 - Double-blind conditions essential: Haarala et al. (2003; double-blind) unable to replicate the results of Koivisto et al. (2000a, 2000b; single-blind) with same exposure set-up and tests.
 - When same exposure set-up is used, results more systematic: Haarala et al. (2003) found same results in two independent laboratories; the two present studies.



Some general observations (1)

- Children were very much slower at some of the reaction tasks
 - There are other observations that support this
 - If age/maturity is important then likely to introduce large variability
- It seems likely that we may only detect an effect twice as large (35 msec) as that seen in adults



Some general observations (2)

- It is probably not surprising that results will be variable
 - Penetration of RF into the head is marginal – and even more so with later phone models
 - Phone design can alter SAR by a large factor
 - So can positioning
 - Clever electronics to save battery life can confuse



Future research

- Are children more vulnerable?
 - Dielectric properties of human tissue as a function of age
 - Other relevant physiological differences between children and adults?
 - SAR distribution in children as opposed to adults
- Do mobile phones affect children?
 - Replication of current studies
 - Subjective symptoms
 - Different parameters: age, exposure set-up, intensity, duration & location (ethical considerations).



More information at: www.cost281.org

A screenshot of a Microsoft Internet Explorer browser window. The title bar reads "COST281 Page - Microsoft Internet Explorer". The address bar shows "http://www.cost281.org". The main content area displays the website header with the COST 281 logo on the left and a navigation menu. The main text area contains the title "COST281 - Potential Health Implications from Mobile Communication Systems" and a newsflash section with several bullet points detailing workshops from May 2004. The browser's status bar at the bottom shows "Internet".

COST281 - Potential Health Implications from Mobile Communication Systems
Thursday, May 27th 2004

COST 281 Newsflash

- May 10th, 2004:
Workshop Presentations
NEW! All the documents and presentations which were presented at the COST/ FGF workshops are now available:
Workshop Helsinki: "Influence of RF Fields on the Expression of Stress Proteins" ["► Go to download"](#)
Workshop Thessaloniki: "Potential bioeffects of new technologies, in particular in the UHF range (300 MHz – 3 GHz)." ["► Go to download"](#)
Workshop Immenstaad: "Can electromagnetic fields used in mobile communications provoke sleep disorders and other cognitive changes?" ["► Go to download"](#)
Workshop Budapest: "Mobile Telecommunication and the Brain" ["► Go to download"](#)
Workshop Reisenburg: "The Blood-Brain Barrier (BBB) - Can it be influenced by RF-field interactions?" ["► Go to download"](#)
- May 4th, 2004:
Workshop in Helsinki, Finland on April 28-29, 2004
"Influence of RF Fields on the Expression of Stress Proteins"
Aim of this workshop was to evaluate and discuss current available experimental data on protein expression under the influence of RF fields. Results from the workshop will be collected and presented in a documentation accepted by the participating experts.
The Workshop was organized by the European Commission's FFG (Research Association for Public Application) in

