

Mobile Telephone Use Is Associated With Changes in Cognitive Function in Young Adolescents

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As part of the Mobile Radiofrequency Phone Exposed Users' Study (MoRPhEUS), a cross-sectional epidemiological study examined cognitive function in secondary school students. We recruited 317, 7th grade students (144 boys, 173 girls, median age 13 years) from 20 schools around Melbourne, Australia. Participants completed an exposure questionnaire based on the Interphone study, a computerised cognitive test battery, and the Stroop colour-word test. The principal exposure metric was the total number of reported mobile phone voice calls per week. Linear regression models were fitted to cognitive test response times and accuracies. Age, gender, ethnicity, socio-economic status and handedness were fitted as covariates and standard errors were adjusted for clustering by school. The accuracy of working memory was poorer, reaction time for a simple learning task shorter, associative learning response time shorter and accuracy poorer in children reporting more mobile phone voice calls. There were no significant relationships between exposure and signal detection, movement monitoring or estimation. The completion time for Stroop word naming tasks was longer for those reporting more mobile phone voice calls. The findings were similar for total short message service (SMS, also known as text) messages per week, suggesting these cognitive changes were unlikely due to radiofrequency (RF) exposure. Overall, mobile phone use was associated with faster and less accurate responding to higher level cognitive tasks. These behaviours may have been learned through frequent use of a mobile phone. *Bioelectromagnetics* 30:678–686, 2009.

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INTRODUCTION

Mobile (cellular) telephones have become an extremely popular form of electronic communication. Australia has been a world leader in the uptake of this technology with 20 million subscribers (or up to 94% of the population) now using a mobile phone. There is increasing use by children, with 23% of those between the ages of 6 and 13 owning a mobile phone. Ownership increases with age and girls are somewhat more likely to own a mobile phone than boys [Downie and Glazebrook, 2007].

However, this widespread exposure to radiofrequency (RF) fields has been accompanied by increasing concern about potential adverse health effects. A number of expert reviews of scientific

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literature and reports from national authorities have been published [Krewski et al., 2004; Stewart et al., 2004; Health Council of the Netherlands 2007; Repacholi et al., 2007; Barnes et al., 2008; Fifth Annual Report From SSI's Independent Expert Group on Electromagnetic Fields, 2008]. While the possibility of tumours was the initial concern about RF exposure from mobile phone use, recently there has been increasing concern about other effects on the brain. This is becoming a focus of research because there is little information in published literature, particularly in relation to children whose brains are still developing.

There is now sufficient experimental evidence that mobile phone exposure¹ does alter brain activity in young adults [Croft et al., 2008], particularly alpha (the 8–13 Hz) electroencephalographic index of neural activity. Such biological effects may be more significant for children, because it has been argued that different head shapes and thinner skulls may make them more susceptible to RF energy [Kheifets et al., 2005; Wiart et al., 2005; Conil et al., 2008]. RF exposure from a mobile phone handset has been associated with slightly shorter reaction times in children [Preece et al., 2005]. However, other short-term experimental exposures have not found any consistent effects on cognitive function in children [Haarala et al., 2005]. Recently, a follow-up of a national birth cohort has suggested that behavioural difficulties around the age of school entry were more likely among children who had been exposed to mobile phones in utero or postnatally [Divan et al., 2008].

To address this lack of evidence regarding cognitive biological effects among children, the authors established the Mobile Radiofrequency Phone Exposed Users' Study (MoRPhEUS). The aims were: to assess exposure to mobile telephones in secondary school students, and to determine whether there were any associations between this exposure and cognitive function.

METHODS

A cross-sectional clustered study was conducted during 2005 and 2006. We recruited 13 government, 4 Catholic and 3 independent secondary schools from

around Melbourne, Australia. The numbers of schools chosen represent the proportions of secondary students attending each sector in Victoria. At each school, one 7th grade home-room class (typical age, 12–13 years) was randomly selected to participate. Parents or guardians of children in the selected class were sent information packages explaining the study. To be included, students had to attend grade 7 at a participating school and the student and parent/guardian had to be able to understand the information on the plain English language sheet and consent form, and willing to comply with study requirements. We excluded students with a known cognitive disorder and those receiving medication or other drugs, known to impair or alter cognitive function.

Of the 479 students invited, 317 (66%) participated in the study—195 from government, 65 from Catholic and 57 from independent schools. We recruited 145 (46%) boys and 172 (54%) girls. The median age was 13 (range 11–14) years. The vast majority (266 or 84%) were born in Australia, and 81 (26%) spoke a language other than English at home. Questionnaires were completed by participating children and their parents. Exposure to mobile telephones was assessed with a modified version of the Interphone questionnaire [Cardis et al., 2007]. The relevant questions are given in the Appendix.

Clearances

MoRPhEUS was approved by the Standing Committee on Ethics in Research Involving Humans at Monash University, the Department of Education and Training, the Catholic Education Office and the principals of all participating schools. Children and their parents/guardians gave informed written consent.

Outcome Assessment

Cognitive function was assessed with a computerised psychometric test battery CogHealthTM (CogState, Melbourne, Australia, 2005) and the Stroop colour-word test. Research staff were trained in administering tests and performing measurements. The battery included several well-validated instruments that tested the following cognitive function domains:

- *Signal detection*: Simple reaction time measured time taken to detect the presence of and perform a motor response to a stimulus, while choice reaction time had the added cognitive demand of discriminating between two stimuli. Accuracy was employed to index possible biased responding. These tasks tested very basic information processing

¹'Exposure' is used to denote different circumstances in different disciplines. In bioelectromagnetics literature it is typically used to denote actual exposure to the electromagnetic fields themselves. However, in the present article as in most of the epidemiological literature, 'exposure' is used to mean reported mobile phone use, which relates to actual electromagnetic fields to differing degrees, depending on type and use of phone, as well as the accuracy of subjective reports of such mobile phone use.

and were used to assess a variety of possible impacts on neural function, including acute mobile phone exposure [Preece et al., 1999].

- **Working memory:** The one-back task indexed the ability to flexibly hold information in short-term memory. It required the child to keep an item in memory for a short period so that it could be compared to another item, and then the first item was discarded from memory and the latter one stored in its place. The two-back task required keeping an item in memory to compare with another item, following an intervening item which was then discarded. The tasks were assessed in terms of reaction time and accuracy, and required strong mnemonic and attentional processes. There are currently mixed results about possible acute effects of mobile phone exposure on working memory [Koivisto et al., 2000; Krause et al., 2000].
- **Simple (One card) learning** was a continuous visual recognition task that assessed visual recognition memory and attention. Children were presented with an image of a playing card and had to respond 'Yes' or 'No', depending on whether the card had previously been displayed.
- **Associative learning:** Children were tested on whether they were able to learn associations between images of playing cards, unlike the simple learning task which required children to remember the cards themselves. Associative learning relates to a separate cognitive domain compared to the tasks described above and has been employed to assess cognitive impairment due to illicit recreational drug use [Croft et al., 2001].
- **Movement monitoring/estimation** (moving card monitoring task) indexed the ability to track and predict the motion of an object. Unlike the cognitive abilities indexed above, this was more akin to performance of ball sports, such as football. Movement monitoring/estimation has proven particularly useful in assessing psychomotor performance, similar to that associated with drug-related driving impairment [Silber et al., 2006].

Students wore headphones to present auditory cues, were given a trial run of all tasks to standardise learning effects, and completed all tasks in succession while the computer program recorded their response times and accuracies.

The *Stroop colour-word test* involved reading words representing the names of colours [Stroop, 1935]. The first subtask (form A) required the child to read 50 words printed in black ink. The child was also asked to name each of four colours presented in 50 meaningless symbols (form C). The interference

subtasks (forms B and D) required the child to read the word or identify the colour in which it was printed, respectively, where the word and colour were incongruous. Completion times and errors were recorded for each form. There is extensive literature on this test, partially because of its strong face validity and its use as a measure of illicit drug use effects on focused attention [Croft et al., 2001].

Statistical Analysis

The primary exposure metric presented in this analysis was $\log_{10}$ total reported number of voice calls made and received per week (LogTotalCalls), which was normally distributed. When the respondent specified a range of calls per week, the arithmetic average was chosen. An offset of 1 was added to include valid zeroes and the distribution truncated at 70 to exclude extreme outliers. Secondary exposure metrics were $\log_{10}$ total number of short message service (SMS, also known as text) messages made and received per week (LogTotalSMS) and duration (years of mobile phone use). Again, the same offset and truncation were applied to the distribution of total SMS prior to log transformation.

In accordance with the manufacturer's recommendations, mean response time for true positives and true negatives was $\log_{10}$ transformed and accuracy was expressed as arcsine transformed hit-rate for each test in the CogHealth battery. Stroop times and error rates were analysed by comparing form B with form A, and form D with form C. Separate multiple linear regression models were fitted to each of these outcomes with LogTotalCalls, LogTotalSMS or duration as the predictor. Standard errors were adjusted for clustering by school using a robust variance estimator (StataCorp., College Station, TX, 2007).

Age, gender, ethnicity (languages other than English spoken at home), socio-economic status and handedness were fitted as covariates. Socio-economic status was estimated from the Socio-Economic Index for Areas (SEIFA) of advantage/disadvantage for the postcode of residence [Australian Bureau of Statistics, 2006], (www.abs.gov.au/AUSSTATS/abs@nsf). Analyses were conducted in SPSS, version 15.0 (SPSS, Chicago, IL, 2006) and Stata version 10 [StataCorp, 2007].

RESULTS

Description of Exposure and Cognitive Test Results

Most (299 or 94%) of the 317 children had used a mobile phone and 243 (77%) had their own phones.

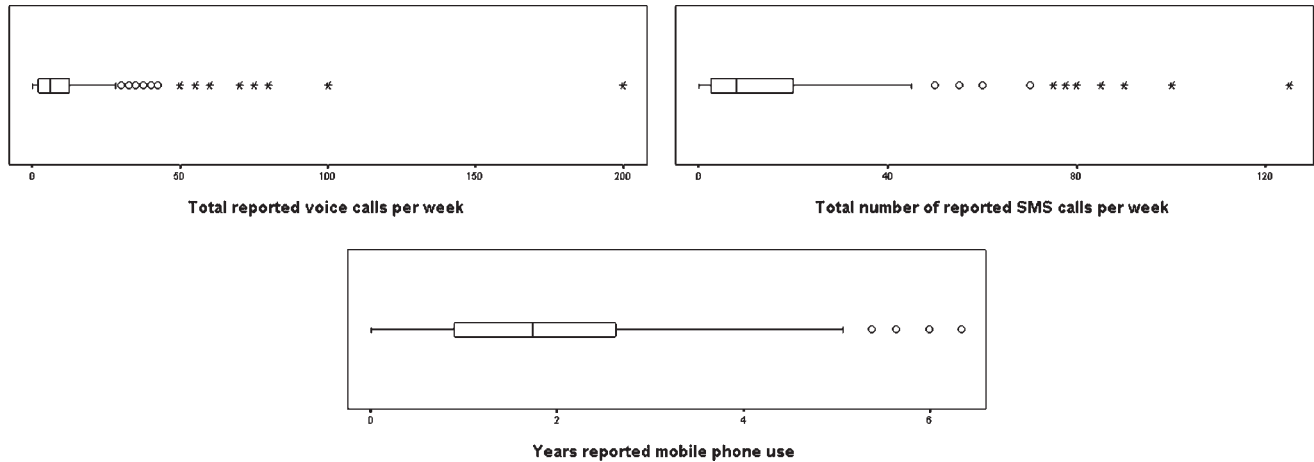


Fig. 1. Boxplots of total reported voice calls per week, total reported SMS calls per week and years reported mobile phone use. The box represents the interquartile range (IQR) and the vertical line the median value. Outliers (cases with values 1.5–3 times the IQR above the 75th percentile) are represented by 'o' and extreme observations (cases with values more than three times the IQR above the 75th percentile) by '*'.

The median total number of reported voice calls per week was 8, with an interquartile range (IQR) from 4 to 15 calls (Fig. 1). The median number of reported SMS messages was also 8 (IQR 2.5–20) per week (Fig. 1). The Kendall nonparametric correlation between the reported numbers of weekly voice calls and SMS was 0.4 ($P < 0.001$). The median reported duration of mobile phone use was 1.74 (IQR 0.89–2.63) years (Fig. 1). The CogHealthTM battery was completed by 315 students and the Stroop test by all 317. There were a few data missing for some tests after removal of nonvalid zeroes; thus some analyses present slightly smaller numbers. Descriptive statistics for the untransformed response times and accuracies of cognitive tests

are given in Table 1, and response times and error counts for the Stroop colour-word test in Table 2.

Associations Between Total Voice Calls and Cognitive Outcomes

Results of the regression models fitted to each CogHealthTM outcome are summarised in Table 3. Negative regression coefficients meant that making and receiving more voice calls per week were associated with shorter response times or less accurate responses. Students who reported more voice calls per week demonstrated shorter response times for the simple and associative learning tasks. Those who reported more voice calls also performed less accurately on working

TABLE 1. Descriptive Statistics for Cognitive Tests in the CogHealthTM Battery

Test	Parameter	N	Median	IQR ^a
Simple reaction time	Response time ^b	315	318	277–387
	Accuracy ^c	315	97.2	92.1–100
Choice reaction time	Response time ^b	314	568	493–679
	Accuracy ^c	314	90.9	85.7–96.8
One-back task	Response time ^b	313	743	636–869
	Accuracy ^c	313	88.2	76.9–93.8
Two-back task	Response time ^b	312	834	700–986
	Accuracy ^c	312	75.7	57.3–88.2
One card learning task	Response time ^b	311	895	735–1092
	Accuracy ^c	311	54.8	45.2–66.7
Associative learning task	Response time ^b	314	1276	1091–1495
	Accuracy ^c	314	71.2	60.4–78.8
Movement monitoring/estimation	Response time ^b	313	473	407–555
	Accuracy ^c	313	83.3	76.9–90.9

^aInterquartile range (25th percentile–75th percentile).

^bResponse time in ms for true positives and true negatives.

^cHit rate (%).

TABLE 2. Descriptive Statistics for the Stroop Colour-Word Test ($n = 317$)

Form	Parameter	Median	Interquartile range
A	Time (s)	20.9	18.6–23.1
	Errors	0	0–0
B	Time (s)	22.7	20.3–26.2
	Errors	0	0–0
C	Time (s)	28.4	25.6–31.6
	Errors	0	0–1
D	Time (s)	46.4	41.2–53.7
	Errors	1	0–2
(B–A)/A	Time ratio	0.10	0.03–0.19
(D–C)/C	Time ratio	0.64	0.49–0.82

memory tests (one-back and two-back tasks) and the associative learning task. Signal detection (simple and choice reaction times) and movement monitoring/estimation were not related to the total number of voice calls per week. There was some evidence that associations with accuracy of working memory ($P = 0.04$ for interaction in both one-back and two-back tasks) were stronger for boys than girls, but there was no effect modification for ethnicity.

The regression models fitted to the Stroop completion time ratios are summarised in Table 4. Students who reported making and receiving more voice calls per week took significantly longer to complete form B (compared to form A), indicating that interference by the word printed in an incongruous colour was greater among more frequent mobile phone users.

Associations Between SMS Messages and Cognitive Outcomes

Table 5 presents relationships between total SMS messages per week and cognitive outcomes. Students

who reported making and receiving more SMS messages demonstrated shorter response times to the simple learning task, but less accurate responses to the working memory (one-back and two-back) and associative learning tasks. Signal detection and movement monitoring/estimation were not related to total SMS messages. There were also no significant relationships between total SMS messages and Stroop completion time ratios (Table 4). There was minimal evidence of effect modification by gender or ethnicity.

To investigate possible joint cognitive effects of the number of voice calls and SMS messages per week, the students were divided into four groups: low calls and low SMS use ($n = 168$), low calls and 'high' (upper tertile) SMS ($n = 40$), 'high' (upper tertile) calls and low SMS ($n = 36$), and 'high' calls and 'high' SMS use ($n = 60$). The effects on working memory were confined to the group with high use of both modalities. The accuracy of the simple reaction test was also reduced in this group. On the other hand, the effect on simple learning was apparent in all groups with more

TABLE 3. Associations (Regression Coefficients and 95% Confidence Intervals) Between Total Reported Voice Calls Per Week and Cognitive Outcomes Adjusted for Age, Gender, Ethnicity, Socio-Economic Status, Handedness and Clustering by School

Test	Parameter	Coefficient	95% CI	P-value
Simple reaction time	Response time ^a	0.005	–0.021, 0.031	0.70
	Accuracy ^b	–0.050	–0.104, 0.004	0.07
Choice reaction time	Response time ^a	0.004	–0.017, 0.024	0.71
	Accuracy ^b	–0.030	–0.093, 0.033	0.34
One-back task	Response time ^a	0.014	–0.009, 0.036	0.23
	Accuracy ^b	–0.091	–0.170, –0.013	0.03
Two-back task	Response time ^a	–0.018	–0.039, 0.002	0.08
	Accuracy ^b	–0.098	–0.169, –0.027	0.01
One card learning task	Response time ^a	–0.051	–0.083, –0.020	0.003
	Accuracy ^b	–0.030	–0.067, 0.007	0.11
Associative learning task	Response time ^a	–0.028	–0.049, –0.007	0.01
	Accuracy ^b	–0.072	–0.108, –0.037	<0.001
Movement monitoring/estimation	Response time ^a	0.001	–0.016, 0.019	0.87
	Accuracy ^b	–0.008	–0.056, 0.041	0.75

^aLog₁₀(response time in ms for true positives and true negatives).

^bArcsine transformed hit rate.

Bold values indicates $P < 0.05$.

TABLE 4. Associations (Regression Coefficients and 95% Confidence Intervals) Between Either Total Reported Voice Calls or SMS Messages Per Week and Stroop Time Ratios, Adjusted for Age, Gender, Ethnicity, Socio-Economic Status, Handedness and Clustering by School

Ratio	Exposure	Coefficient	95%CI	P-value
(B–A)/A	LogTotalCalls	0.040	0.010, 0.070	0.01
	LogTotalSMS	0.013	–0.017, 0.042	0.38
(D–C)/C	LogTotalCalls	0.006	–0.0554, 0.067	0.84
	LogTotalSMS	–0.014	–0.063, 0.036	0.58

Bold values indicates $P < 0.05$.

than a low use of a mobile phone. There were effects on associative learning in those with high numbers of voice calls (Table S1, see Online Supplementary Data).

There were no significant relationships between duration of mobile phone use and any of the cognitive outcomes (data not shown).

DISCUSSION

MoRPhEUS is the first cross-sectional epidemiological study to investigate cognitive biological effects of mobile phone exposure in school-aged children. By the age of 13, most of our sample had used a mobile phone, which is comparable to Swedish data [Soderqvist et al., 2007]. We found that students who reported making or receiving more voice or SMS calls per week, and in particular more of both, demonstrated shorter response times on learning tasks, but less accurate working memory. Consistent with this, those who reported making or receiving more voice calls per week also exhibited poorer inhibitory function (as indexed

by poorer performance on the Stroop). The findings were quite robust when different statistical methods (unadjusted nonparametric, multivariate analysis of covariance) were employed.

The association between mobile phone use and cognition was not restricted to a particular task or cognitive ability. Rather greater mobile phone use was related to poorer accuracy on working memory and associative learning tasks, and faster reaction times on the simple and associative learning tasks. This suggests that rather than being related to a particular cognitive function, it may be related to an impulsive response style of children. In this context, impulsive response style or ‘impulsive behaviour’ refers to the tendency of children to respond before they know the correct answer. Corresponding to this, children who used mobile phones more were faster but less accurate on a number of tasks, suggesting that they may be more impulsive than other children, favouring a quick, and not accurate, solution. It is noteworthy that impulsive behaviour is associated with the type of behavioural

TABLE 5. Associations (Regression Coefficients and 95% Confidence Intervals) Between Total Reported SMS Messages Per Week and Cognitive Outcomes Adjusted for Age, Gender, Ethnicity, Socio-Economic Status, Handedness and Clustering by School

Test	Parameter	Coefficient	95% CI	P-value
Simple reaction time	Response time ^a	0.003	–0.013, 0.019	0.66
	Accuracy ^b	–0.041	–0.097, 0.014	0.14
Choice reaction time	Response time ^a	0.002	–0.016, 0.021	0.80
	Accuracy ^b	–0.048	–0.100, 0.003	0.07
One-back task	Response time ^a	0.006	–0.011, 0.022	0.46
	Accuracy ^b	–0.073	–0.136, –0.010	0.03
Two-back task	Response time ^a	–0.017	–0.035, 0.001	0.06
	Accuracy ^b	–0.066	–0.113, –0.020	0.008
One card learning task	Response time ^a	–0.054	–0.090, –0.019	0.005
	Accuracy ^b	–0.032	–0.074, 0.009	0.12
Associative learning task	Response time ^a	–0.016	–0.039, 0.008	0.17
	Accuracy ^b	–0.049	–0.079, –0.019	0.003
Movement monitoring/estimation	Response time ^a	0.006	–0.006, 0.017	0.29
	Accuracy ^b	–0.008	–0.053, 0.037	0.72

^aLog₁₀(response time in ms for true positives and true negatives).

^bArcsine transformed hit rate.

Bold values indicates $P < 0.05$.

problems in children reported to be associated with prenatal and postnatal mobile phone exposure [Divan et al., 2008].

Another possible explanation that should be considered is whether the computer key pressing behaviour itself may have been altered, rather than the cognitive processes preceding these behaviours. However, we consider this explanation unlikely because speed and accuracy of key pressing were differentially affected across the cognitive domains. The key pressing behaviours were the same across tasks, but relationships were found with only some tasks, suggesting that the cognitions and not the key pressing behaviour were determining the relationships.

Because this was a cross-sectional analysis, it was not possible to determine whether RF exposure had affected cognitive function or whether these findings represented pre-existing impulsive behaviours and/or learned behaviours from more frequent use of mobile phones. The latter possibility is suggested by functions often used in conjunction with SMS, such as 'predictive texting', that in effect, train the user to favour speed over accuracy. Similar results were also found for SMS messages where there is very little RF exposure. Although SMS employs similar techniques to transmit and receive information, it takes only a few seconds and the handset is typically held away from the head when in use. Because the exposure data were collected at the same time as cognitive testing, reverse causality remains possible and that cognitive function could drive mobile phone use. Because the data are inconsistent with these effects resulting from RF exposure, speculation about possible mechanisms of biological interactions with children's brains is not warranted.

There have been very few previous studies of mobile phone biological effects in children, and differences in methodology make it difficult to directly compare our findings. A feasibility study (MobilEe) involving 69 children, 70 adolescents and their parents, in personal dosimetry, interview, quality of life questionnaire and symptom diary was conducted in Munich [Radon et al., 2004]. The investigators concluded that 24 h monitoring was feasible and the questionnaires were well accepted by participants. However, they have not yet reported whether there was any association between RF exposure and quality of life or other outcomes.

Recently, a large Danish national birth cohort followed children up to the age of 7 years [Divan et al., 2008]. Behavioural problems in the children, such as emotional, hyperactivity, conduct and peer problems were assessed. Both prenatal and postnatal maternal exposures to mobile phones were associated with a 1.8-fold increase in reported behavioural problems.

The analysis was adjusted for confounders such as sex of child, age of mother, smoking during pregnancy, mother's psychiatric problems and socio-occupational levels. Although data on lifestyle factors, diet and environmental exposures were collected prospectively, exposure to a mobile phone during pregnancy was only determined at age 7. While this exposure assessment could have been affected by recall bias, the mothers were not aware of the hypothesis being tested.

There is limited consistency in the few studies of experimental RF exposures in children. A randomised cross-over trial with a 902 MHz mobile phone handset was undertaken with 18 children, aged 10–12 years, using a cognitive assessment system [Preece et al., 2005]. Simple reaction time was reduced by 17 ms during the 25 W exposure condition compared to sham exposure ($P = 0.02$). However, the authors dismissed this finding after adjustment for multiple comparisons. Another trial involved 32 children, aged 10–14 years, who completed a battery of cognitive tests during exposure to active and inactive mobile phones [Haarala et al., 2005]. There were no consistent effects of RF exposure on reaction time, choice reaction time, vigilance or *n*-back tasks. While many of these tasks were similar to those that we employed, the mean duration of experimental exposure was only 50 min.

Nonetheless, some cognitive effects of short-term experimental exposures to RF energy similar to that emitted by mobile phones have been previously reported, mainly in small samples of healthy young adults. A meta-analysis of data from 10 such blinded controlled trials has been published [Barth et al., 2008]. The reviewers found small but significant pooled effects of RF exposure on attention and working memory. In particular, reaction times to the subtraction task were shorter and two-back response times were longer, but accuracy was poorer under conditions of RF exposure. Although we did not employ a subtraction task, the poorer accuracy to the two-back task is very similar to what we found in those children who reported more voice calls per week.

The strengths of MoRPhEUS include cluster sampling of all three school sectors, a good participation rate and measurement of cognitive function with a well-validated and age-appropriate test battery. CogHealthTM has been previously used to document cognitive impairment due to sleep deprivation or alcohol intake in young adults [Falleti et al., 2003] and to measure improvements in cognitive performance among normal children between 8 and 12 years of age [Mollica et al., 2005]. The Stroop test has also been successfully used in children of this age [Shum et al., 2008]. The response from students invited to participate was acceptable, but unfortunately we have no data on

nonparticipants to assess representativeness. The analysis was adjusted for clustering by school, although the within-school correlations were quite weak.

The limitations include reliance on self-reported exposure to mobile phones. However, the Interphone questionnaire has been validated against both software-modified phones [Vrijheid et al., 2006] and network billing records in adults [Vrijheid et al., 2008]. This latter approach cannot be adopted in children who mainly use prepaid mobile phone services. Data on duration of calls were not presented because these have been previously shown to be less accurately reported than number of calls [Samkange-Zeeb et al., 2004]. We accept that self-reported use of mobile phones is a poor surrogate for RF exposure and have discussed alternative approaches for epidemiological studies elsewhere [Inyang et al., 2008].

Future epidemiological research needs to adopt a cohort design to determine the correct temporal sequence of mobile phone use and cognitive effects. We are collecting longitudinal data in MoRPhEUS to better investigate changes in exposure and cognitive function over time. Studies also need to be conducted on younger children as exposure is becoming more common in younger age groups. There is reported exposure to mobile phones, albeit infrequently, in 30% of 7-year-olds in Denmark [Divan et al., 2008] and 23% of 6- to 13-year-olds in Australia [Downie and Glazebrook, 2007]. Although the cognitive effects found might appear subtle, the almost ubiquitous exposure means that if caused by mobile phones, they could possibly have considerable public health significance.

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APPENDIX

Selected exposure questions from the modified Interphone questionnaire:

- B3a Have you ever used mobile phones to make or receive calls?
- B3b Do you currently *own* a mobile phone?
- B4 Do you currently *use* a mobile phone?
- B6 How old were you when you first started to use a mobile phone?
- B7 What is the average number of calls you make per week? You can give me a range if that is easier.
- B9 What is the average number of calls you receive on your mobile phone per week? You can give me a range if that is easier.
- B14 What is the average number of text (SMS) messages you send and receive per week? You can give me a range if that is easier.