TEACH[R]

Caffeine consumption among students attending Christian schools in Australia and its relationship to classroom behaviour and academic performance

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Abstract

Caffeinated drinks have become increasingly popular among secondary students in Australia. A total of 949 students in years eight to eleven from 11 Christian schools completed a survey questioning their use of caffeinated drinks, their classroom behaviour and academic performance. The most popular drinks were found to be the carbonated cola/coca, cola/pepsi. Students consumed other caffeinated drinks such as Red Bull, Mother, V and similar products to a lesser extent. The drinks providing maximal delivery of caffeine included iced coffee, cappuccino and plunger coffee. Caffeine use ranged from a majority of students who exhibited low or zero caffeine consumption through to a small group whose weekly consumption reached toward 2 g of caffeine (6 – 8 cups per week). Significant relationships were found between weekly caffeine consumption and self-reported measures of Classroom Behaviour and Academic Performance.

Introduction

Caffeine products are a growing segment of the current marketplace (Gunja & Brown, 2012). The consumption of these products is unregulated and they are finding wider use, particularly caffeinated soft drinks, among children and teenagers (Beckford, Grimes and Riddell, 2015). Indeed, Ludden & Wolfson (2010, p.330) suggest that “Caffeinated soft drinks are a part of youth culture.” However very little is known about how its use is

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related to adolescent sleep, mood and academic performance (Ludden & Wolfson, 2010). Energy drinks, containing considerable concentrations of caffeine, have been marketed to adolescents with claims of increasing energy and mental alertness (Simon & Mosher, 2007); however, recent studies have found high levels of energy drink consumption amongst adolescents. For example, an Australian based nutritional supplements focussed study (O'Dea, 2003) reported 42.3% of the sample of year 7-11 students from a government school had consumed energy drinks over the past two weeks. Costa, Hayley and Miller (2016) report that from their sample of Australian 12-18-year-olds 36% had exceeded the recommended two standard energy drinks /day, and 56% of consumers had experienced negative physiological health effects following energy drink consumption.

"moderate doses of caffeine do not appear to have any influence on complex cognition nor do they appear to have a positive influence on mood"

A review of the caffeine study literature suggests a need for further Australian based adolescent caffeine consumption studies as there is limited research relating to Australian childhood and adolescent caffeine consumption in general (Costa, Hayley and Miller, 2016). Also, the relationship between caffeine consumption and student academic factors needs to be explored. The current study is designed to gain data, within an Australian context, relating to the following questions:

1. What are the levels of adolescent caffeine consumption?
2. What are the sources of caffeine for adolescents'?
3. What are the associations between adolescents' caffeine consumption and student academic factors?

Firstly, this paper briefly describes the history of caffeine use and its effects when ingested into the human body. It also provides information about the caffeine content of a selection of drinks freely available in the Australian market and some confectionary products finding their way to Australia from the United States of America. Secondly, this paper reports on information obtained from nearly 1,000 Australian students enrolled in Christian schools from Brisbane to Perth, about their use of caffeinated drinks and their self-reported academic school behaviour. Finally, this paper explores possible associations between caffeine consumption and school-level academic factors.

Caffeine: History and Chemistry

Caffeine is a psychoactive alkaloid that, when ingested by human beings, increases alertness. It is naturally found in a range of plants including tea leaves, the cocoa bean, the kola nut and the coffee bean. The molecule of caffeine is soluble in boiling water and therefore hot drinks have been the usual means by which people have ingested the slightly bitter-tasting alkaloid. Caffeine is quickly absorbed into the body and, when in sufficient quantity, its effects are perceptible within 15 to 20 minutes of ingestion. The half-life period of caffeine in the human body is variable and appears to lie between three and six hours.

The effect of low-moderate, doses of caffeine

Caffeine acts as a stimulant, and even in low doses (from 30 mg) it will decrease the perception of fatigue and raise the level of alertness (Lieberman, Tharion, Shukitt-Hale, Speckman & Tulley, 2002; Smith, 2002; Winston, Hardwick & Jaberi, 2005). Even though caffeine has the potential to raise the level of arousal, it does not appear to effect sensory perception in any way (Smith, 2002). Caffeine acts as a diuretic and raises blood pressure (Winston, Hardwick & Jaberi, 2005). Since moderate doses of caffeine raise the general level of arousal such doses have been found to improve performance on tasks dependent upon alertness such as simulated driving (Smith, 2002) and sentry duty (Lieberman, Tharion, Shukitt-Hale, Speckman & Tulley, 2002). However moderate doses of caffeine (less than 100 mg) do not appear to have any influence on complex cognition nor do they appear to have a positive influence on mood (Smith, 2002).

Detrimental effects of caffeine

Studies in which large doses of caffeine were administered to experimental participants indicated a range of detrimental effects caused by caffeine. These dosages exceeded 2 mg/kg of body weight and therefore involved doses of in excess of 150 mg and some reached levels of 6 mg/kg of body weight. In other words, they involved instant doses of up to 600 mg of caffeine (Smith, 2002). Studies of this nature found that large doses of caffeine were related to a number of resultant conditions: perceptions of 'jitteriness'; degrees of arousal that made sleep most unlikely if not impossible (Clark and Landolt, 2016); the onset of feelings of nervousness and agitation; and increased feelings of stress and anxiety (Nawrot, Jordan, Eastwood, Rotstein, Hugenholtz & Feeley, 2003; Smith, 2002; Winston, Hardwick & Jaberi, 2005). These studies indicated that caffeine was the causal agent, for the symptoms arose after the ingestion of caffeine and they abated as the caffeine was metabolised.

Further studies have indicated a correlational link between caffeine and other situations. Prolonged heavy use of caffeine correlates with persistent sleeping disorders, eating disorders, perceptions of stress, anxiety disorder and depression (Winston, Hardwick & Jaberi, 2005). One could mount an argument that prolonged use of caffeine is related to insomnia. However, such arguments become tenuous when attempting to link caffeine use with eating disorders and depression. It could be that individuals resort to caffeine use in order to ameliorate an otherwise stressful condition.

When ingested in large quantities, caffeine is toxic. Gunja and Brown (2012) reviewed data gathered by the New South Wales Poisons Information Centre (NSWPIC) over a six-year period ending in 2010. They located 297 hospital reports of caffeine toxicity related to ingestion of caffeine through 'energy drinks'. Over this period the annual trend was sharply upward (12 reports in 2004 to 65 in 2010). The reported symptoms of caffeine toxicity included: palpitations, agitation, tremors, gastrointestinal upset, hallucinations, seizures and cardiac arrhythmia. These individuals reported sequentially drinking from three to eight energy drinks. This equates to a range of caffeine ingestion from 225 mg to in excess of 1000 mg (see Table 1). Of the 297 cases, 50 had co-ingested alcohol. Mixing alcohol and caffeine products is an increasing behaviour among American college students (Malinauskas, Aeby, Oveerton, Carpenter-Aeby & Barber-Heidal, 2007).

'Safe' and 'dangerous' levels of caffeine consumption

Caffeine is a widely used substance and research papers tip-toe around issues of 'safe' and 'unsafe' levels of caffeine use. Doses of 150 mg and upward have been placed in the category of 'high' caffeine use (Smith, 2002). Research dealing with US SEAL teams (super-fit individuals who are prepared to risk life and limb) indicates that maximal functional alertness is achieved by doses of caffeine that do not exceed 200 mg (Lieberman, Tharion, Shukitt-Hale, Speckman & Tulley, 2002). However, it must be acknowledged that use of caffeine products is a world-wide behaviour and that many of these users do so with relative safety. Even so, individuals with existing health conditions need to be wary of the use of caffeine products. Gunja and Brown (2012) point out that as little as 50 mg of caffeine can induce tachycardia and agitation in susceptible individuals. In weighing all this information, it does seem that a single cup of coffee per day (around 100 mg/day) may be a relatively 'safe' practice for healthy adults. However, daily doses that exceed 150 mg may be moving into the regions of risk and doses that exceed 200 mg per day could be considered inadvisable.

Table 1: Caffeine content in commonly available drinks

Drink Type	mg/100 ml of fluid
Coffees – Standard Volumes vary from 250 – 400 ml	
Brewed coffee	45
Espresso coffee	173
Instant coffee	24
Slow extraction (Drip)	61
Plunger extraction	200
McDonalds standard coffee	31
McDonalds iced coffee	42
Starbucks Frappuccino	32
Starbucks Grande Caffe Americano	48
Starbucks Grande Caffe Latte	32
Starbucks Grande Cappuccino	32
Starbucks Mocha	37
Starbucks Grande coffee	70
Starbucks Iced Espresso	32
Starbucks Short coffee	76
Starbucks Tall Caffe Americano	42
Starbucks Tall coffee	76
Energy Drinks – Standard Volumes Vary from 250 – 500 ml	
28 Energy	32
B63 Energy	32
Battery Energy	32
Battery Juiced Energy	32
Big Black V	31
Big Cock	30
BLU	32
Bomba	30
Buzz Monkey	32
Demon	32
Monster	32
Mother	32
No Fear	33

"a single cup of coffee per day (around 100 mg/day) may be a relatively 'safe' practice for healthy adults … doses that exceed 150 mg may be moving into the regions of risk"

Drink Type	mg/100 ml of fluid
Octane	33
Pure Bio Energy	32
Red Bull	32
Rock Star Super	50
Energy 'Shots' – Standard volumes vary from 60 – 80 ml	
6 Hour Power	208
Ammo Energy Shot	578
Demon Energy	333
Coffee Nespresso	163
NOS Energy Shot	416
Reckless Energy Shot	178
V Pocket Rocket	266
Carbonated & Caffeinated Standard volumes vary from 300 – 500 ml	
Coke – Blak	19
Coke – Classic	10
Coke – Zero	10
Coke – Diet	13
Pepsi – Diet	10
Pepsi – Max	19
Pepsi – Cola	11
Mountain Dew	15

"small volume 'shots' … three mini-cans consumed consecutively can deliver in excess of half a gram (500mg) of caffeine in a single episode"

The situation for children could be quite different. While moderate caffeine use (400mgm or 4-5 cups per day) is not generally associated with negative effects by the US Food and Drug Administration (FDA, 2013, para. 11) and the American Medical Association (MedlinePlus, 2015, para.13), this classification is largely based on studies considering adults. In fact, very little research has been conducted on children and adolescents (Temple, 2009). In these cases, smaller body weight means that caffeine doses must be limited. Certainly, it is inadvisable for children with attention deficits to use caffeine products (Smith, 2002). However, for the average healthy older child and young teen, an occasional 300 ml serving of caffeinated carbonated drink (less than 40 mg of caffeine) would not normally be harmful.

Caffeine in the marketplace

During the past century, there has been an expansion in the range of products that include caffeine. Over the past two decades, there has been an exponential increase in the range of caffeinated products. These include cold drinks, candies, gums, ice creams, yoghurts, powders and tablets. The so-called 'energy drinks' are marketed as products that improve performance, endurance and concentration (Gunja & Brown, 2012). Tables 1 and 2 provide an overview of these delivery mechanisms along with estimates of caffeine content. Information provided in these tables has been summarised from sources such as Energy Fiend (2012 a; 2012 b), McCusker, Goldberger and Cone (2006) and Food Standards - FSANZ (2011). Table 1 indicates that drinks of 300 to 500 ml of carbonated and caffeinated soft drink will deliver around 30 to 70 mg of caffeine and the average cup of coffee (around 200 ml) will deliver from 50 to 150 mg of caffeine. However, some extraction processes produce coffees (e.g. plunger coffee, espresso, slow extraction and some Starbucks products – Grande, Short and Tall) capable of supplying in excess of 150 mg of caffeine in a single episode. In addition, some of the energy drinks such as Mother, Demon and Red Bull are marketed in cans with volumes of up to 500 ml.

Again, these latter large volumes are capable of delivering quantities of caffeine in excess of 150 mg per can. However, it is the small volume 'shots' that really have high concentrations of caffeine. Although the quantities within 'shots' are small (60 to 80 ml per mini-can), the concentration is such that three mini-cans consumed consecutively can deliver in excess of half a gram (500mg) of caffeine in a single episode. In addition, some of the candies, powders and tablets can easily deliver in excess of 150 mg of caffeine.

Research method

Data was collected for the 'Caffeine study' through the administration of an anonymous questionnaire to almost 1,000 students from twelve Christian secondary schools across Australia. These students came from years 9, 10 and 11. The questionnaire included a demographic section in which information including age, sex, class and postcode was sought. A list of all caffeinated drinks available in Australia with marketed quantities was provided to the respondents against a numbered code. Respondents were asked to use the code to

Table 2: Caffeine content in candy, foods, powders and tablets

Delivery Mechanism	Type	Caffeine (mg)	Serve
4Ever Fit Caffeine Tablets	Tablet	200	Per tablet
Allen Energy Jerky	Pkt	110	Strip
Alka-Seltzer Wake-up Call	Tablet	65	Per tablet
AmP Energy Gum	Gum	40	Per piece
Baking Chocolate	Squares	23	Per square
Bang!! IceCream	Icecream	125	Per scoop
Bolt 260	Tablet	110	Per tablet
Butterfinger Buz	Candy	80	Per packet
Buzz Bites Chocolate Chews	Candy	100	Per chew
Caffeinated Brownies	Brownies	122	Per brownie
Choco Mallows	Candy	100	Per piece
Hershey's Cocoa Powder		8.4	Per tablespoon
Coffee Mallows	Candy	200	Per piece
Crackheads	Candy	200	Per piece
Crackheads 2	Candy	600	Per piece
Dannon Coffee Yogurt	Yogurt	36	Per tub
Ed Hardy Chocolate Rocks	Candy	600	Per box
FireStar Energy Booster	Sachets	200	Per sachet
Foosh Energy Mints	Candy	100	Per mint
Häagen-Dazs Coffee Icecream	Icecream	48	Per cup
Hero Energy Mints	Candy	82	Per mint
Jaya Mallows	Candy	280	Per piece
Extreme Sports Jelly Bean	Candy	50	Per 130g
Lightning Rods	Candy	60	Per rod
Milk Chocolate	Candy	20	Per 100g
Mocca Mallows	Candy	200	Per piece
Magnum Tablets	Tablet	200	Per tablet
Starbucks Coffee Icecream	Icecream	60	Per cup
Stay Alert gum	Gum	100	Per piece
Turbo Truffles	Candy	150	Per truffle

"While it is important to understand the health impacts of caffeine, it is of interest to consider the impact that caffeine consumption has on academic performance at school."

indicate their consumption of quantities of specific caffeinated drinks against morning, afternoon and evening time slots as a kind of diary for the previous seven days.

While it is important to understand the health impacts of caffeine, it is of interest to consider the impact that caffeine consumption has on academic performance at school. To this end, two academically oriented self-reported scales were generated in the present study to obtain some understanding of student factors that may influence their academic success. Firstly, their behaviour in the classroom (Classroom Behaviour) using a four-point Likert scale, and secondly, the students

Table 3: Respondents' age and sex

Age	Male	Female	Total
13	2	1	3
14	84	93	177
15	150	160	310
16	128	150	278
17	80	78	158
18	18	10	28
Total	462	492	954

For these students 47.5 % of their caffeine source was caffeinated soft drinks, 34.7% was teas and coffees of various types and 17.8% from energy drinks.

Table 4: Respondents' religion

Religion	Male	Female	Total
SDA	167	194	361
Other Christian	156	157	313
None Christian Religion	37	57	94
No Religion	87	73	160
Total	447	481	928

Table 5: Language of the respondents' home

Language of the Home	Male	Female	Total
English	350	372	722
Other	69	68	137
Total	419	440	859

also self-reported their academic position within their class (Academic Performance) on a three-point scale: Upper third, middle third or lower third. T-tests and One-way Analysis of Variance were used to locate points of difference between respective respondent groups.

Results and analysis

Demographic data (age, religious affiliation and gender) collected about participants and their responses indicating caffeine consumption, follow. Subsequent analysis considers group differences in caffeine consumption and associated effects on learning (Classroom Behaviour and Academic Performance).

Respondents

The students in the 'Caffeine study' came from years 9, 10 and 11 and were aged between 13 and 18 years (See Table 3). A total of 954 sets of responses were entered into the computer for analysis, representing 462 males and 492 females.

A total of 674 reported their religion as 'Christian', 94 were of non-Christian religions and a total of 160 indicated that they belonged to no religion (see Table 4). Further, a total of 137 (roughly 14%) indicated that English was not the first language of their home (Table 5). This indicates that the respondents were not typical of the broader Australian population where about 40% in the 2011 Census indicated that they are not Christian and around 25% speak languages other than English in the home (ABS, 2011).

Caffeine consumption

Types of caffeine consumption

The caffeinated drinks consumed by 531 respondents over the course of 1 week are listed in Table 6. The 375 mL can of Coke was the most commonly consumed item, totalling 594 purchases within the week prior to completing the questionnaire. Its caffeine content at less than 40 mg is modest. However, it was the coffees and the 'energy drinks' that contained higher doses of caffeine. Purchasing or mixing a 450 ml mug of instant coffee (each containing approximately 108 mg of caffeine) was reported 167 times, with a further 156 purchases of the 250 ml cup of instant coffee (each containing 60 mg of caffeine). While consuming 250 ml of iced coffee (105 mg of caffeine) was reported 119 times, only 31 reported consuming 600 ml of iced coffee (252 mg of caffeine). Of the 'energy drinks' there were 134 purchases of Angel, 92 purchases of Pussy 250 ml, 66 purchases of Monster 500 (150 mg of caffeine), 65 purchases of V Energy 250 ml, 61 of Mother 500 (also 150 mg of caffeine), 56 of Red Bull 250, 52 of BadBoy and 48 or RockStar. A total of 43 respondents bought 'Shots' of highly caffeinated liquids.

From this data, it can be seen that caffeine source can be collapsed into three broad categories: Caffeinated soft drinks, teas and coffees, and energy drinks. For these students 47.5 % of their caffeine source was caffeinated soft drinks, 34.7% was teas and coffees of various types and 17.8% from energy drinks.

Table 6: Caffeinated drinks used by respondents in one week

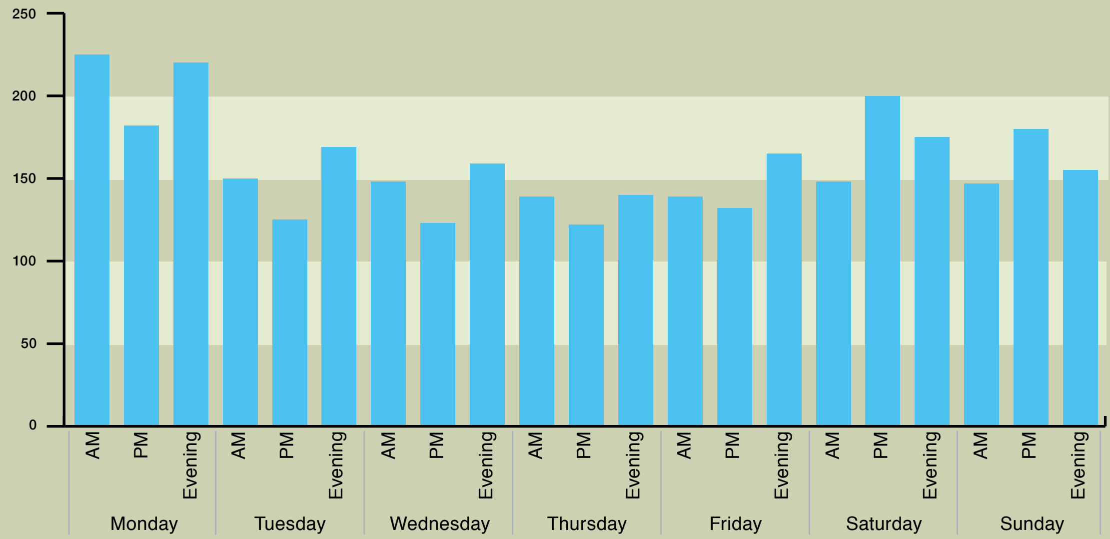
Drink	Weekly Consumption	Drink	Weekly Consumption
Coke 375	594	Iced Coffee 600	31
Coke 250	334	Cappuccino 450	30
Coke 600	238	Endorush 473	29
Pepsi 375	197	Iced Tea Tall	29
Black Tea 450	174	Espresso 250	24
Instant Coffee 450	167	Red Bull (Shot) 60	23
Instant Coffee 250	156	Iced Coffee Tall Glass	20
Black Tea 250	154	Red Bull 355	16
Angel 300	134	V Energy 350	14
Pepsi 250	132	Iced Coffee 375	14
Iced Tea 500	108	Plunger Coffee 250	14
Cappuccino 250	97	Climax	13
Pussy 250	92	Demon 500	13
Other Cola 375	84	Demon Shot	11
Other Cola 250	84	Red Bull 330	11
Pepsi 600	72	Iced Coffee 750	10
Iced Tea 250	70	Red Eye 330	9
Iced Coffee 250	69	Superman 250	8
Monster 500	66	V Energy (Shot)	8
V Energy 250	65	Demon 250	6
Mother 500	61	Wicked 475	6
Red Bull 250	56	ZU Energy 250	6
BadBoy 250	52	Plunger Coffee 450	6
Iced Coffee Cup 250	50	Wild NRG 375	5
Rock Star 473	48	Rock 250	4
BadBoy HotShot	42	Espresso 450	4
Mother 250	42	Flying Power Shot	1
Wicked 375	41	Pure Energy 250	1
Iced Coffee 500	39	Samedi 500	1
Other Cola 600	38	Smart Energy 250	1
Citron	33		
V Energy 500	32		

"Fifty two participants reported using in excess of 1200 mg over the course of a week, more than 171mg per day [in the region of risk]"

Total caffeine consumption

Overall, 501 respondents reported zero use of caffeinated drinks over the course of the previous week. A use of 600 mg or less for the week was reported by 315 respondents. Seventy-seven reported consuming between 600 mg and 1200 mg for the week, or between 85 mg and 171 mg per day. Fifty two participants reported using in excess

Figure 1: Caffeine consumption by 531 respondents in mg as calculated for the morning, afternoon and evening of each day for a week



> *No significant gender differences were found in total caffeine consumption … There were, however, significant differences in caffeine consumption across age groups*

of 1200 mg over the course of a week, more than 171 mg per day (Table 7). In other words, while most respondents reported consuming modest amounts of caffeine in a week, a small proportion of users (about 16%) were potentially consuming quantities that placed them in a 'region of risk' (Gunja and Brown, 2012).

The average weekly caffeine consumption across the whole sample was 256.6 mg or 36.6 mg per day. For the caffeine users, however, the average weekly caffeine consumption was 473.7 mg or 67.6 mg per day.

Caffeine consumption distribution

Figure 1 provides the pattern of caffeine consumption over the course of a single week. It can be seen that Mondays and Saturdays were the two days in which caffeine consumption peaked. It is tempting to consider the Monday high point as the recovery time from weekend activities!

Religious affiliation and caffeine consumption differences

One-way analysis of variance results reveal differences in caffeine consumption rates across the respective religious affiliation rates [$F(3,929) = 6.939$, $p < .001$]. Tukey post hoc tests indicate that those who reported themselves as being affiliated with the 'Christian' or 'No Religion' groupings consumed significantly larger quantities of caffeine per week compared with those who reported themselves as being affiliated with the 'Seventh-day Adventist (Christian – SDA) Christian' and the 'No Religion' groupings (Table 8).

Gender and Age caffeine consumption differences

No significant gender differences were found in total caffeine consumption, with the males registering a weekly average caffeine consumption of 279.9 mg and the females of 232.6 mg.

There were, however, significant differences in caffeine consumption across age groups, with greater consumption as age increased [$F(3,941) = 3.084$, $p = .027$]. The 14-year-olds reported consuming 195.5 mg per week, the 15-year-olds 226.6 mg, the 16-year-olds 274.6 mg and the 17+ age group 334.3 mg per week.

There was a large number of students who did not consume any caffeine in the two weeks prior to the survey across the respective age categories. This is illustrated by the number of cups per day data outlined in Table 9. One cup of instant coffee or one caffeinated soft drink per day most often converts to an intake of just under 600 mg per week. For students aged 14, 53.3% reported they did not consume any caffeine in the previous two-week period, but this figure drops to only 35.8% for 17+ Years students. Also, 3.3% of 14-year-olds reported consuming 3+ cups of coffee per day but this figure increased to 8.4% for students aged 17+ years.

Overall, the level of caffeine consumption was

Table 8: Weekly caffeine consumption across religious affiliation groupings

Religious Affiliation	Mean Weekly Caffeine Consumption (mg)	Standard Deviation
Christian	323.4	537
Christian - SDA	176.3	403
Other Religion	212.6	394
No Religion	327.9	541

Table 9: The distribution of caffeine consumption across student ages

Caffeine consumption	Students 14 years	Students 15 years	Students 16 years	Students 17+ years
No Caffeine (0 cups per day)	53.3%	48.9%	42.0%	35.8%
0 to 600 mg per week (1 cup per day)	37.2%	38.8%	42.0%	47.5%
600 to 1200 mg per week (2 cups per day)	6.1%	8.8%	9.4%	8.4%
More than 1200 mg per week (3+ cups per day)	3.3%	3.6%	6.5%	8.4%

> *While caffeine consumption was relatively low, the current study did find a link to academic factors in school students.*

Table 10: Classroom Behaviour scale items

Classroom Behaviour (Chronbach's alpha = 0.70)	
Item	**Loading**
I do not get on well with my teachers	0.73
I often misbehave I class	0.71
I am frequently in trouble with my teachers	0.69
I do not enjoy classwork	0.64
I find classwork boring	0.60

Table 11: Mean values of male and female self-reported Classroom Behaviour Scales

Classroom Behaviour Scale (Positive): Mean Value			
Age Category	Males	Females	N
Age 14	2.58	2.79	180
Age 15	2.66	2.76	306
Age 16	2.63	2.87	275
Age 17+	2.82	2.95	178
Total	**2.67**	**2.83**	**939**

reasonably low. This is in line with The Australian Bureau of Statistics Health Survey (Kalisch, 2015), which found that older Australians consumed more caffeine than younger Australians with the over 30 years consuming a daily median intake of over 150 mg and daily mean intakes of over 170 mg for age groups 31-50 and 51-70 years (over 4 cups of black or 1.5 espresso shots of coffee). Caffeine consumption of greater than 1200 mg per day (3 plus cups of coffee) was less than 10 percent in all of the student age groups, however less than 10% of 14-year-olds consumed more than 1 cup per day.

Caffeine and learning

So what is the relationship between the level of caffeine consumption revealed in this study and student learning in the classroom? While caffeine consumption was relatively low, the current study did find a link to academic factors in school students. Two academic factors were investigated; the Classroom Behaviour scale was derived from five survey items (scale items and loadings are *"a general pattern of decreasing average scores on these scales [behaviour and performance] against the [increasing] … caffeine use."*

Figure 2: Mean classroom behaviour ratings against caffeine consumption

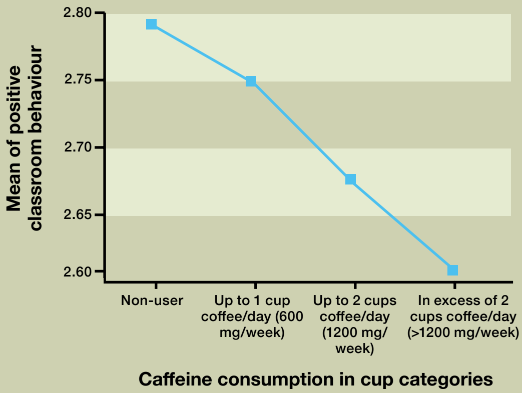
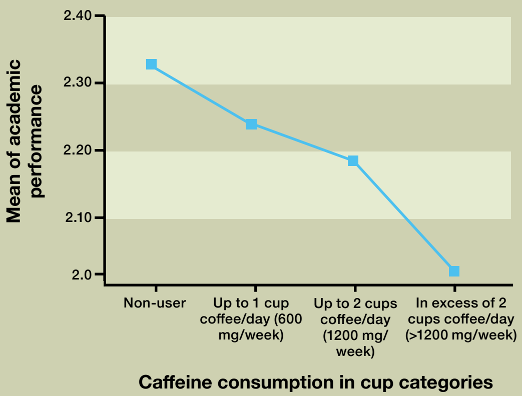


Figure 3: Mean academic performance ratings against caffeine consumption



outlined in Table 10). Class Position was self-reported in relationship to three levels (upper, middle, and lower third of the class).

Factors that co-relate with increasing caffeine use

The distribution of respondents' mean scores on the Classroom Behaviour scale is shown in Table 11. There was a significant difference in the Classroom Behaviour mean scale scores across the respective ages [F(3,938) = 5.017, p=0.002] with Classroom Behaviour ratings improving with age. As expected, the females registered significantly higher classroom behaviour means than the males [t(937) = 4.648, p=0.001].

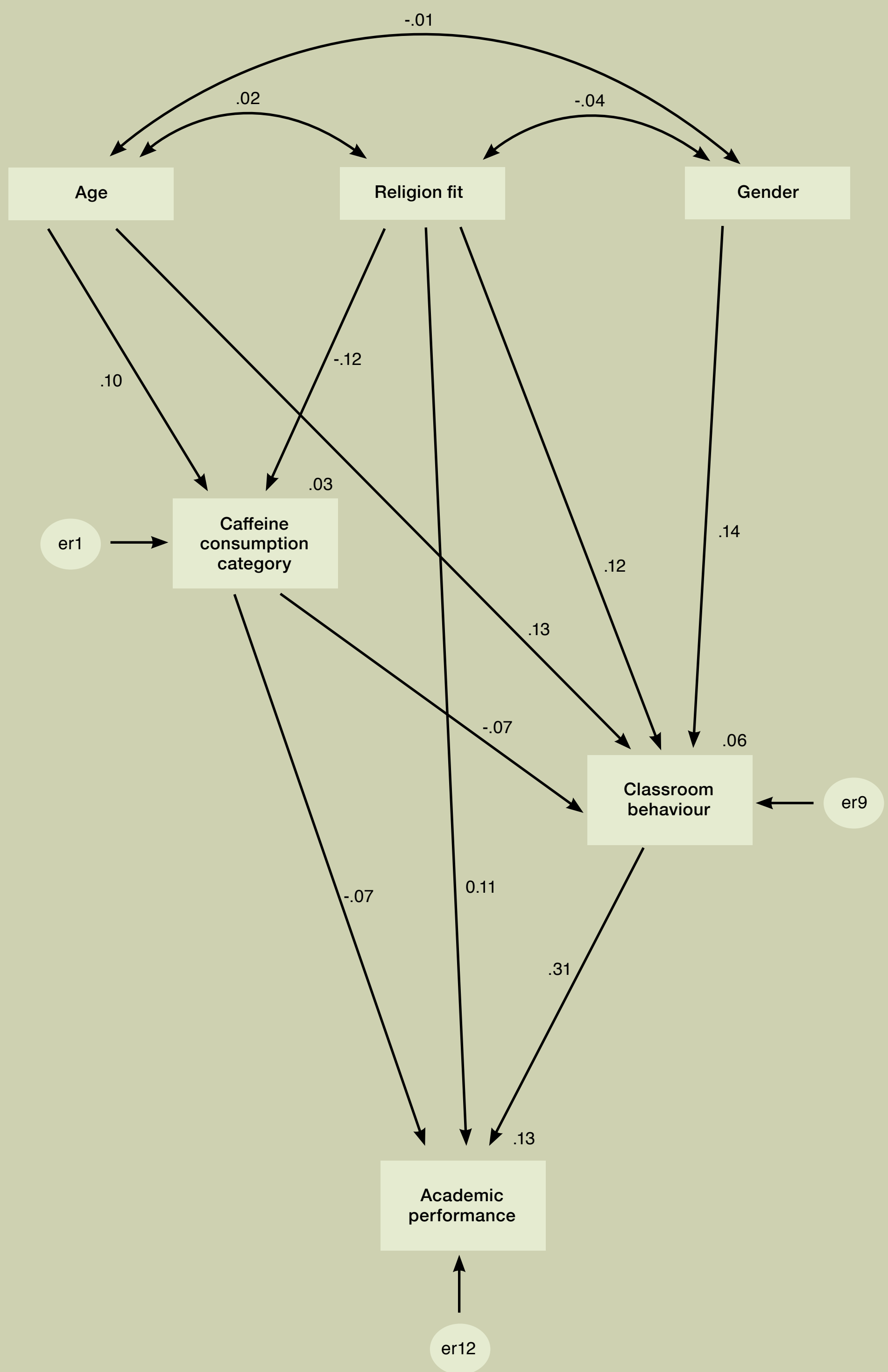
The scores on the Classroom Behaviour and Academic Performance scales were examined against the categories of weekly caffeine consumption. Levene's test for homogeneity of variances (p >.05) indicated that population variances for each consumption group are approximately equal, enabling mean based analysis of the data. Graphs of these results are shown in Figures 2 & 3. These figures indicate a general pattern of decreasing average scores on these scales against the cup categories of weekly caffeine use. Cohen's d was calculated to determine the effect size of the significant difference between the non-caffeine user group and the high caffeine user group. For Classroom Behaviour [t(501) = 2.041, p = .042] Cohen's d for the difference between the caffeine use groups was 0.30 and for Academic Performance [t(501) = 3.210, p = .001] Cohen's d was 0.45; both small effects (Field, p. 32).

Finally, Structured Equation Modelling (SEM) using AMOS 24 software was performed to explore the relationships between Age, Gender, Religion Fit (the degree to which the student's religion was similar to the school's religion), Caffeine use, Classroom Behaviour and Academic Performance. Based on these variables an optimal model with all pathways being significant (Figure 4) was derived by making use of the iterative process of inspection of statistical significance of path coefficients and theoretical relevance of constructs in the model (Joreskog & Sorbom, 1993). The model as a whole fitted the data well with base-line comparisons fit indices, NFI = .970, IFI =.983 & CFI =.982; well above the 0.9 considered criteria for a good fit. Further the root-mean-square error of approximation was 0.035; less than 0.05 which is considered to indicate a close fit between data and the model (Bentler, 1980, Ho, 2006, Byrne, 2010).

The model indicates that 13% of the variance in academic performance was accounted for by Age, Gender, Religion Fit, Caffeine Use and Classroom Behaviour. As student age increases total weekly caffeine use increases (beta = 0.10), and the female students are more likely to exhibit positive classroom behaviour (beta = 0.14). What is important to note is that Caffeine Consumption (beta = -.07), and Religion Fit (beta = .11) both have small (but opposite sign) direct effects on Academic Performance, but Classroom Behaviour (beta = 0.31) has a larger positive direct effect. The pathway analysis suggests that an increase in caffeine consumption will have a small negative impact on academic performance both directly and through the mediating variable Classroom Behaviour. Further the degree of similarity between the student's religion and the school's religion has a positive impact on Academic Performance.

Based on these findings it can be concluded

Figure 4: Academic performance, caffeine use and classroom activity



> *increase in caffeine consumption will have a small negative impact on academic performance both directly and through the mediating variable Classroom Behaviour.*

that student caffeine intake has a small negative effect on both student classroom behaviour and student academic performance. Interestingly a previous study by the article's authors (Greive et al., 2014) indicated that sleep problems also had an impact on classroom behaviour and academic performance and a combination analysis is required to generate a greater understanding of the impact of both caffeine use and sleep problems on students' classroom activities.

> *The study … found that increasing caffeine- use was related to lower ratings of classroom behaviour and academic performance. … [but] makes no claim of causality*

Conclusion

This study has established that caffeine is a commonly available and unregulated psycho-active substance and has explored the use of caffeine by school students. The respondents were students in years nine to 11 in Australian Christian schools and were not completely representative of Australian youth. Just over half of the respondents (55%) revealed that they had used caffeinated drinks in the week previous to the completion of the survey. While the most popular caffeinated drink was Coca Cola, it was the coffees and energy drinks that provided the higher doses of caffeine. A total of 142 respondents (approximately 15%) admitted to using in excess of 600 mg in the week prior to the survey. In the same period, 27 respondents indicated use of in excess of 2000 mg of caffeine.

The study also found that increasing caffeine-use was related to lower ratings of classroom behaviour and academic performance. While the paper makes no claim of causality, that is, the paper does not argue that caffeine use by the students was responsible for these lower ratings, it does claim however, that caffeine-use is not going to alleviate the situation, rather it is likely to aggravate these classroom issues.

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