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The Superstitious Scholar: Paranormal Belief within a Student population and its relationship to Academic Ability and Discipline

Commented [R1]: We have amended our title from 'The Sceptic Scholar' as we feel the word superstitious captures the essence of this research better and ties into the measures used within this study.

Abstract

The development and application of critical thinking skills are an important component of success at University. Such skills permit students to evaluate the strengths and weaknesses of evidence, argument and theory. However research suggests that many students believe in paranormal phenomena (e.g. telekinesis). Such beliefs defy the basic principles of science and do not stand up to critical scrutiny. This study aimed to investigate paranormal beliefs within a student population; differences among gender, academic discipline, and academic performance were explored. Findings indicated that females expressed higher levels of paranormal belief than males, 'hard' science students (e.g. Biology) and 'soft' science students (e.g. Sociology) expressed lower levels of belief than arts students, and a significant negative correlation indicated that high achievers were less likely to endorse paranormal beliefs. In light of these results we suggest that paranormal phenomena may be a useful tool for teaching critical thinking skills at University.

1. Introduction

Successful academic outcomes at University are dependent on students being able to develop and apply a number of higher-order cognitive skills (North, 2005; McLean & Miller, 2010; Ghanizadeh, 2017). Specifically students must be able to communicate critical thinking and rational reasoning abilities within many of the assessments that they are compelled to undertake (Choy & Chea, 2009). Watson and Glaser (1980) suggest that critical thinking involves five key areas such as: inferring between degrees of truth or falsity, recognition of assumptions or presumptions in given statements or assertions, deducing whether certain conclusions follow necessarily from the information provided, interpreting whether generalisations drawn from given data are warranted, and evaluation of strong and or weak arguments relevant to the question at issue (Watson & Glaser, 1980; El Hassan & Madhum, 2007). Presumably, critical thinking permits students to form objective judgements through the effective analysis and evaluation of available evidence (Ghanizadeh, 2017).

Nonetheless, it should be recognised that the level of such skills required for successful completion of assessments will vary between disciplines (Fink, 2003). Indeed, a distinction between different scientific branches is important to make, for example 'purer' scientific disciplines (such as Physics or Engineering) tend to maintain consistent fixedness over methods of investigation, aims and evaluation criteria, indicating a more fact based methodology; whereas 'softer' scientific disciplines (such as Humanities or Anthropology) frequently encourage a view that knowledge is subjective and a matter for interpretation, thus allowing students to take a more broad minded approach to their studies (North, 2005). Essentially it can be assumed that different academic disciplines would require varying degrees of critical thinking.

Several studies have indicated that students of engineering and mathematic disciplines generally demonstrate stronger critical thinking skills than students of humanities and social sciences (Arum & Roksa, 2011; Brint, Cantwell & Saxana, 2011; Fong et al, 2017). More so, differences in critical thinking appear further amplified when comparing artistic disciplines with purer scientific ones

Commented [R2]: Referee 4: 'Relationship to Literature' we have removed to overuse of the reference Ghanizadeh, 2017. It now appears only twice in this section

(AlAbdulwahab, Kachanathu & AlKhamees, 2016; Furnham & Crump, 2013). A recent study which compared health science students with art students found that the former demonstrated superior cognitive skills in components such as overall knowledge, calculation, and critical thinking ability (AlAbdulwahab, Kachanathu & AlKhamees, 2016). Moreover, Furnham and Crump (2013) reported that art students were more sensitive and imaginative, and tended to have lower numerical intelligence scores than their scientific correlatives, of whom were found to have higher fluid and numerical intelligence and tended to be more practical and tough-minded (Furnham & Crump, 2013). Ultimately these reported contrasts in personality and cognition could signify further individual differences between these groups.

Despite the evidence suggesting that students hold varying degrees of critical thinking abilities, it is therefore surprising that belief in the paranormal is widespread amongst student populations; with female students often reporting higher levels of belief than males (Peltzer, 2002). Spinelli, Reid & Norvilitus (2002) found that over 75% of 193 students held a belief in at least one of four types of paranormal phenomena (clairvoyancy, telepathy, precognition, and psychokinesis), with 42% reporting an experience of at least one of these paranormal activities. An additional study found student belief in the paranormal to be extensive, with 99% of 176 psychology majors expressing paranormal beliefs (Messer & Griggs, 1989).

Paranormal phenomena, if authentic, describes stimuli which defy the basic principles of science; therefore it can be expected that students of scientific disciplines may express lesser beliefs than their artistic counterparts. This idea was evidenced by Grimmer and White's (1992) research into the paranormal belief of Australian non-science and science students. These findings determined that arts students generated the highest levels of belief in the paranormal, with the opposite being the case for medical students (Grimmer & White, 1992). These differences could be attributed to the medical students having developed superior critical thinking abilities in comparison to their artistic peers, deeming them less likely to hold such beliefs. However not all evidence has supported

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10 this result; Wiseman and Watt's (2006) review of psychic ability and psychological attributes
11 determined that, while some studies found students of scientific backgrounds less likely to express
12 belief in psychic ability, others reported results divergent to this consensus. A notable example
13 being a study conducted by Salter and Routledge (1971), which indicated that Biology students
14 were more likely to believe in the paranormal than those who studied humanity-based subjects
15 (Wiseman & Watt, 2006; Salter & Routledge, 1971).

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20 Research has also observed differences in paranormal belief and academic performance. Messer &
21 Griggs (1989) found negative associations between student's academic performance and belief in
22 the paranormal, with those achieving lower grades reporting higher levels of paranormal belief.
23 This certainly corresponds with the idea that critical thinking ability may be related to paranormal
24 belief, and further studies have found a link between paranormal belief and cognitive deficiencies
25 (Wierzbicki, 1985; Musch & Ehrenberg, 2002). Wierzbicki (1985) demonstrated a significant
26 negative correlation between paranormal belief and performance of a syllogistic reasoning task,
27 ultimately suggesting that believers had inferior critical thinking abilities than their sceptical peers.
28 Musch and Ehrenberg's (2002) research returned similar findings, this study measured critical
29 thinking ability, among students, by collecting probability judgements and average weighted
30 secondary school grades. It was concluded that critical thinking ability accounted for the
31 relationship between paranormal belief and probabilistic reasoning (Musch & Ehrenberg, 2002).
32 However these results are not definitive representations, as some studies have reported contradictory
33 findings (Stanovich, 2016; Stanovich, 2011; Hergovich & Arendasy, 2005; Emmons & Sobal,
34 1981). For example, Stanovich (2016) posits that individuals can be both irrational and perform
35 well at University, and Emmons and Sobal (1981) found that low education and unemployment was
36 not predictive of paranormal belief. Yet this study did find significant gender differences, which are
37 consistent with empirical research suggesting that females are more likely to believe in the
38 paranormal than males (Peltzer, 2002; Spinelli, Reid & Norvilitus, 2002; Emmons & Sobal, 1981).

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10 While many studies suggest a link between critical thinking ability and paranormal belief, the wider
11 literature appears to suffer from a lack of consistency, thus indicating a need for further
12 investigation. With this position in mind, the following study aimed to explore the association
13 between belief in the paranormal and critical thinking ability, as assessed by academic achievement.
14 Academic achievement was used to reflect this ability by using both grade criteria (below average,
15 average, above average) and subject type (hard science, soft science, artistic). Using this design
16 three predictions were made; the first being that significant gender differences would be portrayed
17 in correspondence with previous research. It was expected that females would report higher levels
18 of paranormal belief than males. The second hypothesis regarded differences in critical thinking
19 abilities and subject type, hence predicting that students studying artistic disciplines would be more
20 likely to believe in the paranormal than those of purer scientific ones. Finally, in using the grade
21 criteria variable, it was expected that a relationship between critical thinking ability and paranormal
22 beliefs would again be reflected, with those who obtained higher grades expressing lower levels of
23 belief.
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2. Method

2.1. Sample

The sample included 687 students, all of which completed Tobacyk's (2004) 26-item Paranormal Belief Scale. Of this sample, 374 were females with 267 males; 46 participants did not report their gender. 169 reported their age which ranged from 18 to 65 years ($M=24.62$), 103 were females ($M=25.05$), with 66 males ($M=23.93$). Participants varied in their year of study; ranging from foundation (year 0) to Masters (year 4). 636 students reported their degree title; 87 were enrolled on "Artistic" courses, 414 "Soft Science" courses, and 135 on "Hard Science" courses. In this sample 162 students reported their three most recent grades; 39 attained below average grades, 47 attained average grades, and 76 attained above average grades.

2.2. Measures

Paranormal Belief:

To assess paranormal belief a 26-item Paranormal Belief Scale was used (Tobacyk, 2004). The scale consisted of 7 subscales: Traditional religious belief (4 items); Psi belief (4 items); Witchcraft (4 items); Superstition (3 items); Spiritualism (4 items); Extraordinary Lifeforms (3 items); and Precognition (4 items) (Tobacyk, 2004). The points on this scale ranged from 1 ("strongly disagree") through 4 ("undecided or don't know") to 7 ("strongly agree"); in relation to each item (Tobacyk, 2004). This scale was a revision of Tobacyk & Milford's (1983) paranormal belief scale and is suggested to provide stronger reliability and validity, less restriction of range, and greater cross-cultural validity when measuring the paranormal beliefs of Western cultures (Tobacyk, 2004). Furthermore, a Cronbach's Alpha coefficient indicated that this scale had high internal consistency across this sample ($\alpha = .921$).

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10 Academic Discipline:

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12 A second measure assessed which subjects the students were enrolled on as split amongst three
13 categories; Artistic, Soft Science, and Hard Science. In total students were enrolled on 86 different
14 degrees which included BA Art Practice, BSc Business Studies, and MSc Accounting. Artistic
15 subjects encompassed all Bachelor of Arts courses as well arts based foundation degrees. Soft
16 Science subjects were characterised as being of a humanistic or social science based nature; such as
17 Psychology and Educational studies. Hard Science subjects were characterised as having
18 foundations in Physics/Mathematics, Chemistry, or Biology. These subjects included Engineering
19 and Medical Science courses. Subject types were categorised according to commonly applied
20 definitions of “hard” and “soft” sciences (Fanelli, 2010; Smith, Best, Stubbs, Johnston, &
21 Archibald, 2000). Features characteristic of “hard science” subjects encompassed rigorous
22 application of the scientific method, and a reliance on quantifiable data and mathematical models;
23 whereas “soft science” subjects tended to be more subjective in nature with lower degrees of
24 accuracy and objectivity (Fanelli, 2010; Smith, Best, Stubbs, Johnston, & Archibald, 2000). The
25 “Artistic” subjects were categorised as such for totally lacking any scientific methodology or basis.
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37 Academic Achievement:

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39 In a similar method to Musch & Ehrenberg’s (2002) study, a third measure assessed higher-order
40 cognitive abilities. To reflect these experimenters requested that participants include their three
41 most recent grades from their assignments. These were then quantified to depict their overall
42 average grades, which were then categorised into three groups; “below average” (which ranged
43 from 38.33 to 54.67), “average” (which ranged from 55 to 64.67), and “above average” (which
44 ranged from 65 to 96.67). These were determined according to the mean average reported grade
45 within this sample ($M=64.86$, $SD=14.68$); therefore any average grades above 65 were considered
46 “above average”. Subsequently categorisation of “below average” grades was determined using the
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10 'Grade Point Average' classification system as applied by Oxford Brookes University (Andrews,
11 2016). Therefore in accordance with this system, any grades averaging below 55 were considered
12 adequately "below average" in relation to the overall sample. Data was assessed for authenticity,
13 and scores from two students who reported they had attained 100% on all 3 assessments were
14 excluded.
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21 *2.3. Procedure*

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24 The questionnaires were distributed to students of varied disciplines via opportunity sampling. The
25 students voluntarily filled out the questionnaires after giving informed consent, their anonymity and
26 confidentiality was assured. Furthermore students were given debrief credentials and the option to
27 ask questions for clarification. There was no time limit given for completion of the questionnaire.
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3. Results

3.1 Gender differences:

The descriptive statistics indicate that males attained the highest grades ($M=67.66$), and females reported higher paranormal belief scores ($M=84.07$). Furthermore, females reported higher levels of belief in all the subscales except for "Extraordinary Lifeforms".

Table 1: Descriptive statistics and an independent t-test for average grades and paranormal belief scale and subscales scores, by gender:

Scale	Mean (standard deviation)			Independent samples t-test		
	Full sample	Males	Females	df	t	p
Total PBS score:	79.99 (30.31)	72.76 (30.67)	84.07 (29.70)	639	4.68	.001*
Mean grade:	64.43 (14.68)	67.66 (14.64)	62.32 (14.40)	160	-2.29	.023*
Paranormal belief subscales:						
Traditional religious beliefs	3.68 (1.81)	3.36 (1.92)	3.85 (1.70)	639	3.39	.001*
Psi	2.76 (1.26)	2.61 (1.28)	2.83 (1.24)	639	2.13	.033*
Witchcraft	2.73 (1.64)	2.44 (1.62)	2.86 (1.62)	639	3.21	.001*
Superstition	2.29 (1.53)	1.98 (1.40)	2.54 (1.59)	639	4.68	.001*
Spiritualism	3.12 (1.63)	2.68 (1.65)	3.39 (1.57)	639	5.47	.001*
Extraordinary Lifeforms	3.10 (1.27)	3.17 (1.34)	3.02 (1.21)	639	-1.46	.144
Precognition	2.86 (1.52)	2.42 (1.41)	3.14 (1.53)	639	6.06	.001*

* Statistically significant difference

An independent samples t-test was conducted to compare the gender differences between average grades, total paranormal belief scores, and the seven paranormal belief subscales. As shown in Table 1 there were significant gender differences for mean grade scores, with males achieving higher grades, and significant gender differences for total paranormal belief scores, indicating females were more likely to believe in the paranormal than males. There were also significant differences between gender and paranormal belief of all subscales except 'Extraordinary Lifeforms'.

3.2 Differences by subject type (Hard Science, Soft Science, and Artistic):

As shown in Table 2, a one-way between participants ANOVA revealed significant differences between total paranormal beliefs scale scores and the three subject types. There were also significant differences within the subscales: Psi, Witchcraft, Superstition, Spiritualism, and Precognition.

Table 2: One way ANOVA between subject type, total paranormal belief scale score and paranormal belief subscales:

Scale	Subject Type			ANOVA		
	Hard Science	Soft Science	Artistic	df	F	P
Total PBS score:	69.94 (30.52)	80.85 (30.32)	88.12 (27.26)	2	10.84	.001*
Mean grade:	80.22 (13.47)	61.70 (10.09)	51.76 (12.45)			
Paranormal belief subscales:						
Traditional religious beliefs	3.48(2.11)	3.67(1.77)	3.93(1.59)	2	1.57	.207
Psi	2.47(1.13)	2.78(1.27)	3.07(1.21)	2	6.45	.002*
Witchcraft	2.50(1.89)	2.72(1.57)	3.13(1.59)	2	4.002	.019*
Superstition	1.76(1.32)	2.38(1.52)	3.60(1.46)	2	10.31	.001*
Spiritualism	2.50(1.60)	3.19(1.63)	3.19(1.17)	2	14.73	.001*
Extraordinary Lifeforms	3.01(1.30)	3.12(1.30)	3.19(1.17)	2	.607	.545
Precognition	2.23(1.43)	2.95(1.52)	3.26(1.41)	2	15.52	.001*

*statistically significant difference

Post-hoc tests using the Bonferroni correction determined that there were non-significant differences between 'Artistic' groups, 'Soft Science' groups, and total paranormal belief score however there were statistically significant differences between 'Soft Science' and 'Hard Science' groups ($p=.001$) and 'Hard Science' and 'Artistic' groups ($p=.001$). Differences between subject groups were also observed within five of the seven subscales; differences in Psi belief were observed between the 'Artistic' and 'Hard Science' groups ($p=.001$) and 'Soft Science' and 'Hard Science' ($p=.039$), belief in Witchcraft varied between the 'Hard Science' and 'Artistic' groups

($p=.015$), belief in Superstition varied between 'Hard Science' and 'Artistic' ($p=.001$) and 'Soft Science' and 'Hard Science' groups ($p=.001$), Belief in Spiritualism varied between the 'Hard Science' and 'Artistic' ($p=.001$) and 'Soft Science' and 'Hard Science' groups ($p=.001$), and belief in Precognition varied between the 'Hard Science' and 'Artistic' ($p=.001$) and 'Soft Science' and 'Hard Science' groups ($p=.001$).

3.3 Differences by grade criteria (Below Average, Average, and Above Average):

A one-way between-participants ANOVA revealed significant differences between total paranormal beliefs scale scores and the three grade criteria; Above Average, Average, Below Average. There were significant differences within the subscales; Traditional Religious beliefs, Witchcraft, Superstition, Spiritualism, and Precognition.

Table 3: One-way ANOVA between grade criteria, total paranormal belief scale score, and paranormal belief subscales:

Scale	Grade criteria			ANOVA		
	Below average	Average	Above average	Df	F	P
Total PBS score:	102.02(26.57)	89.44(28.92)	76.14(30.66)	2	10.50	.001*
Paranormal belief subscales:						
Traditional religious beliefs	4.58(1.57)	3.98(1.60)	3.65(1.86)	2	3.76	.025*
Psi	3.4(1.29)	2.79(1.18)	2.59(1.16)	2	6.38	.002*
Witchcraft	3.75(1.70)	2.91(1.48)	2.58(1.2)	2	7.27	.001*
Superstition	3.30(1.61)	2.90(1.68)	1.92(1.23)	2	13.50	.001*
Spiritualism	4.07(1.49)	3.57(1.50)	2.89(1.64)	2	7.79	.001*
Extraordinary Lifeforms	3.49(1.29)	3.39(1.25)	3.05(1.19)	2	2.03	.134
Precognition	3.76(1.42)	3.50(1.52)	2.82(1.55)	2	5.88	.003*

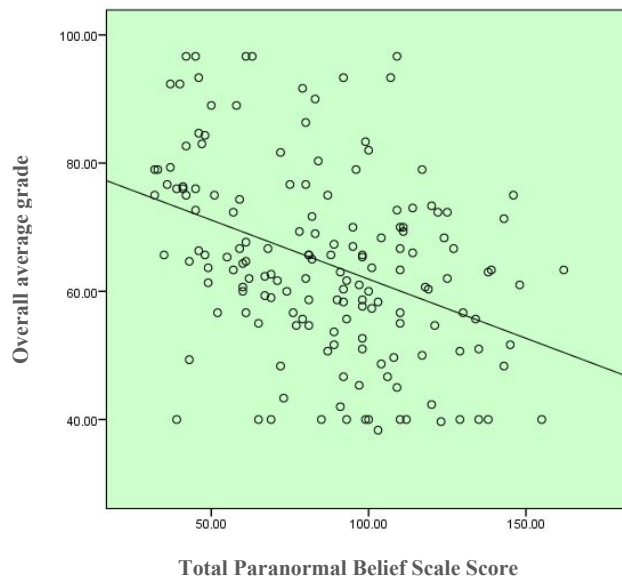
*Statistically significant difference

Post-hoc tests using the Bonferroni correction determined that there were statistically significant differences between Above Average and Below Average groups ($p=.001$) as well as the Above

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10 Average and Average groups for total paranormal belief score ($p=.046$). Differences between grade
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12 criteria were also found within five of the subscales; differences were observed between the
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14 Below Average and Above Average groups for Traditional Religious Beliefs ($p=.020$), differences
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16 were observed between the Above Average and Below Average ($p=.002$) and Below Average and
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18 Average groups ($p=.047$) for belief in Psi. Differences were observed between the Below Average
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20 and Average groups ($p=.042$) and Above Average and Below Average groups ($p=.001$) for belief in
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22 Witchcraft, and there were differences between the Below Average and Above Average ($p=.001$),
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24 and Average and Above Average groups ($p=.001$) for belief in Superstition, differences were also
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26 observed between the Above Average and Below Average groups ($p=.001$) for belief in
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28 Spiritualism, and there were significant differences between the Above Average and Below Average
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30 groups ($p=.001$) and Average and Above Average groups ($p=.05$) for belief in Precognition.

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32 *3.4 Associations between academic achievement and paranormal belief score, including the seven*
33 *subscales:*

34 Figure 1: Scatterplot demonstrating the negative correlation between overall average grade and total PBS score:



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10 There was a statistically significant negative Pearson correlation coefficient for mean grade and
11 Paranormal Belief Scale score; $r = -.388$, $n = 162$, $p = .001$, suggesting that higher grades indicate lower
12 PBS scores. There were also statistically significant negative correlations across all seven of the
13 subscales: Traditional Religious Beliefs; $r = -.213$, $n = 162$, $p = .001$, Witchcraft; $r = -.311$, $n = 162$, p
14 $= .001$, Psi; $r = -.314$, $n = 162$, $p = .001$, Precognition; $r = -.314$, $n = 162$, $p = .001$, Extraordinary
15 Lifeforms; $r = -.173$, $n = 162$, $p = .014$, Spiritualism; $r = -.352$, $n = 162$, $p = .001$, and Superstition; $r = -$
16 $.401$, $n = 162$, $p = .001$.

21 3.5 Summary:

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24 Overall these findings indicate that females held stronger paranormal beliefs than males. Moreover,
25 students studying artistic subjects held the highest levels of paranormal beliefs when compared to both
26 soft science and hard science students, with hard science students reporting the lowest levels of
27 paranormal beliefs. Finally, differences were also found among grade criteria, with “below average”
28 students reporting the highest levels of paranormal beliefs, followed by “average” students, with
29 “above average” students reporting the lowest paranormal belief levels.

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4. Discussion

These findings support the three main hypotheses: that females would report higher belief scores than males, that 'hard science' students would report lower belief scores than 'artistic' students, and that students who achieved 'below average' grades would report higher paranormal belief scores than those who achieved 'above average' grades. However this study also determined group differences outside of the original hypotheses, which will be examined below.

Gender:

Numerous studies have indicated that females are more likely to believe in the paranormal than males, therefore the findings of the present study support this hypothesis (Emmons & Sobal, 1981; Tobacyk & Milford, 1983; Peltzer, 2002; Spinelli, Reid & Norvilitus, 2002). However not all studies have reached this consensus, as Tobacyk, Miller, and Jones (1984) found gender differences to be non-significant. It should be considered that other factors may have influenced these variances, for example the present study also found that males obtained higher average grades than females. This could be an indication that the males had stronger academic abilities, thus evidencing the idea that those with greater critical thinking skills would be less likely to express paranormal beliefs. Females also reported higher belief scores on all but one of the subscales: 'Extraordinary Lifeforms'. Whilst some research has demonstrated that males are more likely to believe in extraordinary life forms, the results from the present study were non-significant; yet this may be an interesting line of enquiry for future research (Clarke, 1991; Dag, 1997; Rice, 2003). Ultimately this study appears to support empirical findings amongst gender and paranormal beliefs; yet it should be noted that gender groups were not equally depicted. Of the 687 participants 46 participants did not report their gender, 374 were recorded as females, with 267 males. Therefore there is a chance that females were disproportionately represented within this study, thus amplifying the statistical differences between gender, paranormal belief scales, and average grades

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10 Academic Discipline:

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12 The present study found statistically significant differences between the paranormal beliefs of 'hard
13 science' students and 'artistic' students. These findings support Grimmer and White's (1992) study,
14 which determined that scientific students were less likely to express paranormal beliefs than non-science
15 students. Therefore these results may evidence the idea that the critical thinking skills developed through
16 study discipline could lower the likelihood of paranormal belief; as the nature of such beliefs would
17 require an absence of scientific reasoning. Furthermore, the present study demonstrated that 'soft
18 science' students were also statistically more likely to express paranormal beliefs than their 'hard
19 science' counterparts; albeit not to the extent of the 'artistic' students. While it may argued that critical
20 thinking ability is a key objective of 'soft science' subjects, this result supports studies which indicate
21 that mathematically based students demonstrate stronger critical thinking abilities than social science
22 students (Arum & Roksa, 2011; Brint, Cantwell & Saxana, 2011; Fong et al, 2017). However there may
23 be other factors equating to these differences, for one 'hard science' students achieved the highest
24 average grades followed by 'soft science' students, with 'artistic' students reporting the lowest grades. It
25 could be argued that non-believers are attracted to 'hard' scientific disciplines, therefore a preconceived
26 natural bias might have equated to the present study's results rather than been influenced by the critical
27 thinking aspects of a given subject type. Yet the finding that 'hard' science students significantly
28 reported the highest grades may endorse the idea that those with stronger cognitive and/or critical
29 thinking abilities may be drawn to 'harder' scientific disciplines, with heightened critical thinking
30 abilities explaining why non-believers might be drawn to such disciplines. Moreover, because artistic
31 subjects were categorised as such for totally lacking any scientific elements, it can be assumed that there
32 was a distinction between level of critical thinking reflected by the artistic and both hard and soft science
33 grades. Although arguably this assumption cannot be applied to variances in critical thinking among the
34 hard and soft science grades, as knowledge for all science disciplines are tested using elements of critical
35 thinking and knowledge retention; knowledge retention may be more indicative of cognitive ability

rather than critical thinking. Therefore future studies which employ academic achievement as a measure would benefit from more accurately discerning whether graded assessments index cognitive or critical thinking abilities. Ultimately the present study's finding evidence the theory that superior cognitive abilities, perhaps regardless of academic discipline, may decrease the likelihood of belief in the paranormal. Yet these findings are limited due to disproportionate representations amongst courses. Of the 636 participants who reported their degree title, there were 414 'soft science' students, 135 'hard science' students, and only 87 'artistic' students. Whilst the 'soft science' students appear to have been over-represented, differences between the 'artistic' and 'hard science' groups can sufficiently be applied to the question at issue: whether differences in paranormal belief can be predicted by differences in critical thinking ability as distinguished by study discipline.

Academic Achievement:

The present study found statistically significant associations between academic performance and paranormal belief. These results support those of previous studies which have also indicated that high academic achievers are less likely to express paranormal beliefs (Musch & Ehrenberg, 2002; Messer & Griggs, 1989). The present study found larger differences between the 'above average' and 'below average' grade groups, with smaller differences between the 'average' and 'above average' grade groups. There were non-significant differences between the paranormal beliefs of 'average' students and 'below average' students, therefore indicating that 'above average' achievers were significantly less likely to express paranormal beliefs than both groups. This result could evidence the idea that those with stronger critical thinking abilities are less likely to believe in the paranormal. Although it could be argued that the measures used in the present study were insufficient representations of critical thinking ability; as the values were taken from the student's three most recent grades, therefore some assignments may not have been a test of critical thinking per-se. Alternatively the use of graded assignments could be considered a measure of cognitive ability instead; therefore these findings may provide some insight into Wierzbicki's (1985) significant correlation between paranormal belief and performance on a syllogistic

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10 reasoning task. In terms of limitations, it should be contested that academic achievement and/or
11 cognitive ability are not valid indicators of critical thinking. This is because people can be both irrational
12 and intelligent, or could achieve high grades at University but hold irrational views (Stanovich, 2011;
13 Stanovich, 2016). Therefore future studies should focus on distinguishing between measures of cognitive
14 and critical thinking ability, and explore whether these measures differentially impact paranormal
15 beliefs. Moreover the factors equating to belief in the paranormal can encapsulate much more than
16 critical thinking abilities, and artistic qualities, as this field can transcend into consciousness studies,
17 anthropology, and variances cultural attitudes (Willard & Norenzayan, 2013; French & Wilson, 2007;
18 Shanafelt, 2004). Therefore the present study is limited in that the field of paranormal belief is somewhat
19 larger than this research implies. The present study was further limited as there were disproportionate
20 representations of each group; with 76 'above average' students, 47 'average' students, and only 39
21 'below average' students. As discussed, the 'hard science' students achieved much higher average grades
22 than the 'artistic' students, with the 'soft science' student's grades falling between these two groups.
23 This could be a demonstration that the 'hard science' group had superior cognitive abilities in
24 comparison to the 'artistic' group, and thus reported lower paranormal belief scores; or this difference
25 could be due to the lack of variation of grades amongst the subject types. However, because the available
26 research suggests significant differences in critical and cognitive abilities amongst academic discipline, it
27 is expected that the former is the case (Arum & Roksa, 2011; Brint, Cantwell & Saxana, 2011; Furnham
28 & Crump, 2013; AlAbdulwahab, Kachanathu & AlKhamees, 2016; Fong et al, 2017).

43 Association between Academic Achievement and Paranormal Beliefs:

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45 A significant negative correlation coefficient further supported the main research question; whether
46 academic achievement can be predictive of paranormal beliefs. Additionally this result further
47 supports the findings of previous studies, which indicated that high academic achievers were less
48 likely to hold such beliefs (Musch & Ehrenberg, 2002; Messer & Griggs, 1989). This was also the
49 case across the seven subscales, with belief in Superstition determining the highest negative
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Commented [R5]: Referee 2: 'Results' we have included the fact that paranormal beliefs are associated with much more than what has been touched on in this study.

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10 coefficient. Essentially this research suggests that superstitious beliefs are substantially less
11 prevalent amongst high academic achievers, and while this finding was not predicted by the original
12 hypotheses this may be an interesting subject for future studies. However, this finding is limited in
13 that academic achievement was assessed using the students' self-reported three most recent grades,
14 and therefore this measure may be vulnerable to reliability and validity issues. Due to data
15 protection restrictions it was not possible to assess grades for authenticity. However, researchers do
16 consider students were honest in their responses, as a wide variety of grades were reported,
17 including many at the lower end of the spectrum.
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24 Using Paranormal Phenomena to enhance Critical Thinking Skills:

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26 The finding that academic achievement and paranormal belief were negatively correlated could
27 suggest that paranormal belief can be used to strengthen critical thinking skills in an undergraduate
28 population. Correspondently, some educational research has demonstrated how belief in the
29 paranormal can be utilised for strengthening critical thinking abilities (Wilson, 2018; Stark, 2012;
30 McLean & Miller, 2010; Wesp & Montgomery, 1998). A classic study conducted by Wesp and
31 Montgomery (1998) demonstrated how critical thinking can be improved in undergraduate students
32 following exposure to a course in paranormal phenomena. Specifically this study demonstrated how
33 critical thinking can be applied to paranormal phenomena to detect flaws in reasoning. Critical
34 thinking was evaluated by providing the students with two 300 word articles before and after
35 exposure to the course, both of which were written by the authors. The first article described how
36 geographic location supposedly influences extroversion, whereas as the second described the impact
37 of diet on friendliness. Each article included ten flaws including overgeneralisation, appeal to
38 authority, and poor or lacking control groups. Following exposure to the paranormal course on
39 critical thinking, students were able to accurately identify more reasoning flaws in the second
40 article, thus demonstrating how paranormal phenomena can be adapted to improve critical thinking
41 skills (Wesp & Montgomery, 1998). This classical finding has been further supported by
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contemporary studies, which used similar designs and found comparable results (Wilson, 2018; Stark, 2012; McLean & Miller, 2010). For example a study conducted by Wilson (2018) demonstrated how a course in critical thinking can reduce belief in the paranormal and pseudoscience within an undergraduate population (2018). Initially, the participants' endorsement in such beliefs ranged from 21-53%; however following administration of the critical thinking course, beliefs in paranormal and pseudoscientific subcategories had reduced by up to 28.9% (2018). The researchers concluded that by improving critical thinking skills, belief in paranormal and pseudoscientific subjects can be significantly lowered (Wilson, 2018). Ultimately both of these studies depict how belief in the paranormal can be used to teach students how to harness critical thinking abilities. More so, the development of such skills can lead to a reduction in paranormal beliefs; therefore these findings are consistent with evidence which suggest a negative association among critical thinking ability and paranormal belief. Presumably, paranormal beliefs could be used to teach critical thinking and increase academic achievement. Hence future research should investigate how paranormal beliefs can be used to illustrate the fallibility of human reasoning, in order to lay the foundations for critical thinking abilities. Whether this method might improve academic performance, or influence changes to academic interests, should also be assessed.

4.1 *Implications*

Ultimately the findings from the present study have inspired some interesting directions for future research. The result that females reported higher belief scores on all but one of the subscales (Extraordinary Lifeforms) could complement findings from earlier studies (Clarke, 1991; Dag, 1997; Rice, 2003). Some research has demonstrated that males are more likely to believe in extraordinary lifeforms; therefore future enquiries should include this variable for further exploration (Clarke, 1991; Dag, 1997; Rice, 2003). A significant negative correlation coefficient supported prior evidence which suggested that high academic achievers are less likely to hold paranormal beliefs, and belief in Superstition determined the highest negative coefficient (Musch &

Commented [R6]: Referee 4: 'Significant revision required' We have amended this section to include alternate supporting references.

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Ehrenberg, 2002; Messer & Griggs, 1989). This result specifies that superstitious beliefs are less prevalent amongst high academic achievers; therefore future research should primarily focus on associations between superstition and academic achievement in order to investigate why this effect occurs. Additionally, the finding that 'hard science' students achieved the highest overall grades, followed by 'soft science' students, could imply that non-believers are more likely to be attracted to scientific disciplines, potentially due to heightened cognitive and/or critical thinking abilities. Therefore future research should explore this avenue in order to garner insight into individual differences amongst subject choices at University. It should also be considered that succeeding studies which employ academic achievement as a measure of critical thinking should accurately discern whether assignments measure critical thinking or cognitive ability. This is to ensure assumptions can be applied to variances in critical thinking and cognitive ability amongst separate disciplines. Both hard and soft science subjects are assessed using elements of critical thinking and knowledge retention, and knowledge retention may be more indicative of cognitive ability than critical thinking. Thus future studies should focus on distinguishing between measures of cognitive and critical thinking ability, and subsequently explore whether these measures differentially impact paranormal beliefs. Lastly, a key implication for this research would be to explore how paranormal beliefs can be harnessed as a method of teaching critical thinking skills. Previous research has evidenced that lessons in critical thinking can attenuate paranormal beliefs; therefore future studies should investigate whether illustrating the fallibility of such beliefs could lay the foundations for critical thinking skills (Wilson, 2018 Stark, 2012; McLean & Miller, 2010). Ideally, this should also be explored in relation to variances in academic performance and academic interests.

4.2 Conclusions

To summarise, the findings from the present study support the idea that cognitive ability, critical thinking ability, and academic achievement can index paranormal beliefs (Musch & Ehrenberg, 2002; Grimmer & White, 1992; Messer & Griggs, 1989; Wierzbicki, 1985). This research also

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provides some insight into the relations among paranormal beliefs and academic interests, as well as academic interests and academic ability. Yet this study does suffer from disproportionate group representations; therefore this limitation should be amended for future replications. The implications of the present study could provide some direction to HE educators wishing to utilize paranormal beliefs as a means of teaching critical thinking skills, and thus increase academic achievement amongst student populations.

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