INNOCENT OR GUILTY: What factors affect jurors' comprehension of DNA evidence, and does comprehension effect their verdict?

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CONTENTS

DECLARATION

This thesis contains no material which has been accepted for the award of any other degree or diploma in any University, and to the best of my knowledge, this thesis contains no materials previously published except where due reference is made. I give consent to this copy of my thesis, when deposited in the University Library, being available for loan and photocopying.

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ABSTRACT

BACKGROUND AND AIMS The impact of DNA evidence on juror decision making is critical. Jurors find DNA evidence the most reliable form of forensic evidence, and cases where DNA is presented by the prosecution are more likely to lead to a conviction. However, the way DNA is presented in court is often complex and difficult for jurors to understand. This study aimed to explore how comprehension of DNA evidence effects conviction rates, as well as confidence that the right verdict was reached. We also investigated how levels of education effect both comprehension and rates of conviction. **METHOD** 270 participants read a summary of a crime where DNA evidence was found. Participants were then presented with expert witness testimony explaining the DNA evidence and how it was analysed. The 'complex' condition testimony had a Flesch readability score of 38 (University reading level). The 'simple' condition had a Flesch readability score of 62 (approximately year 10 reading level). Participants were then asked questions to test their comprehension of the testimony, if they found the defendant guilty or innocent, and how confident they were in the verdict. **RESULTS** The data showed that participants in the simple condition had higher comprehension scores than in the complex condition, and there was a higher rate of conviction in the simple condition. Data also showed that participants with a bachelor's degree were more likely to convict than those who completed year 12.

1. Introduction

Since the discovery of DNA and its incorporation into courtroom evidence, legal proceedings have been transformed, providing jurors, judges and lawyers a valuable tool to help exonerate the innocent and condemn the guilty. DNA (an acronym for deoxyribonucleic acid) is a double helix molecular chain of complementing nucleotide base pairs. In layperson's terms these base pairs contain the instructions the body needs to build an individual person, and therefore each person's DNA represents their unique genetic 'blue print' (Smith & Bull, 2009). DNA can be extracted from a person's blood, skin cells, saliva, semen and other bodily fluids, and the unique genetic code does not change throughout a person's lifetime. Therefore, if a person leaves DNA behind at a crime scene then it can be matched to them, providing strong evidence that they were at the scene. DNA evidence has been referred to as "the single greatest advance in the search for the truth" (Maeder, McManus, McLaughlin, Yamamoto & Stewart, 2016). This statement appears to reflect how juries feel. While DNA evidence presented in court is often complex and difficult for the average juror to understand, mock juror studies have shown that when they are presented with DNA evidence it influences their decision making (Lieberman, Carrell, Miethe & Krauss, 2008). Mock jurors viewed the victim as more believable, the defendant as less believable, and convicted more frequently when the prosecution presented DNA evidence during a case (Golding, Yozwiak, Stewart, Djadali, & Sanchez, 2000).

Despite evidence showing that DNA has a persuasive effect on juror decision making, many studies have established that other variables can interfere with this persuasiveness. Devine and Caughlin (2014) compiled an in-depth meta-analysis of these studies. They

concluded that certain characteristics of both defendant and prosecution, such as the defendant's prior criminal record, defendant's SES, defendant's race (in conjunction with juror race), juror authoritarianism, complexity of the testimony, juror legal system trust, and juror gender in cases involving sex-related crimes, interfered with DNA persuasiveness. Research has also revealed that these other variables are especially pertinent when there is contradictory evidence, such as conflicting eyewitness reports, or when the legal requirements are confusing to jurors (Kovera, McAuliff & Hebert, 1999).

Studies have found mixed evidence about how well jurors comprehend forensic evidence. Some studies on real life juries have found that the majority can understand scientific evidence (Rose & Diamond, 2006; Hans & Vidmar, 2004). Whereas others have found that their comprehension can be limited (Cecil, Hans & Wiggins, 1991).

The purpose of the current study was to explore how the complexity and participant comprehension of the DNA testimony presented in court effects whether they choose to convict, as well as how confident they are that their decision was the correct one. The study will also explore how levels of education and specific knowledge of biology effects conviction rates, as well as beliefs about the reliability of DNA and eyewitness testimony.

Understanding how jurors process this kind of information may help lawyers, judges, expert witnesses, and police officers communicate evidence and its legal importance more effectually. Additionally, insight into what influences a juror's verdict can provide a basis in the development of protocols to reduce juror bias and enable defendants to get a fair trial.

1.2. DNA Evidence and Eyewitness Testimony

DNA evidence has been used in criminal court cases since 1986. It was first used to verify the confession of a 17-year-old boy of two rape-murders committed in the UK, where

molecular biologist Alec Jeffreys had been investigating the use of DNA for criminal trials (Calandro, J. Reeder & Cormier, 2005). Since this case DNA has been widely used in court, in an extensive variety of cases, and studies have shown that generally DNA is reliable and valid (Lieberman, Carrell, Miethe & Krauss, 2008). However, Lieberman and colleagues cautioned that while DNA may be considered the "gold standard" of forensic evidence, it is far from perfect and jurors should consider the other evidence presented when choosing to convict. Liberman et al also suggested that persecutors should use DNA evidence to strengthen an already compelling case, not as the main piece of persuasive evidence. Saks and Koehler's (Saks, 2005) study found that in 86 occurrences of wrongful conviction— found to be wrongful as DNA evidence later exonerated the defendant— errors made in the testing process were responsible for 63% of those cases, and 27% were due to untrue or misleading forensic science testimony from an expert witness. This study shows that despite DNA being mostly valid and reliable, and a powerful tool in exonerating the wrongfully convicted, this kind of evidence can be misinterpreted by the jury due to lack of understanding, errors in protocol, human errors, and purposeful misleading (Lieberman, Carrell, Miethe & Krauss, 2008, Saks, 2005).

In recent years researchers have explored a phenomenon known as the 'CSI Effect', where jurors overestimate and have unrealistic expectations about forensic evidence. The CSI effect claims that jurors expect to see forensic evidence in a criminal trial due to the way forensic evidence is gathered and presented in crime shows. When there is no, or little forensic evidence jurors are less likely to convict (Tyler, 2006). However, there are conflicting reports on whether this effect exists, (Ewanation, Yamamoto, Monnink & Maeder, 2017)**.** Other studies have also found that jurors perceive DNA evidence as superior, and it can be so powerful that it influences juror decisions even when other evidence is mistaken for DNA evidence. Lieberman et al. (Lieberman, Carrell, Miethe & Krauss, 2008) showed that participants incorrectly

identified blood type evidence (where the defendant's blood type matched that found at the crime scene) as DNA evidence.

Lieberman and colleagues (2008) found that most mock jurors rated DNA evidence as the most accurate form of evidence. They also rated it as the most persuasive, rating it more highly than fingerprints, fibre analysis, videotape footage, alcohol/drug tests, expert testimony, suspect confession, victim testimony, and eyewitness testimony. This same study also found that evidence that included scientific analysis, not only DNA testimony, was perceived as more accurate and persuasive than evidence like eyewitness testimony and identification line ups. Golding and colleagues (Golding, Stewart, Djadali, Yozwiak & Snachez, 2001) similarly discovered that mock jurors found a guilty verdict more often when DNA evidence was presented than when only eyewitness testimony was presented. They found a guilty verdict the most often when there was a combination of DNA and eyewitness testimony. Jurors also most often listed DNA evidence as the most important factor when they were asked what influenced their decision. However, as in other studies, the introduction of contradicting eye witness/alibi evidence lessened the effect of DNA evidence (Kovera, McAuliff & Hebert, 1999).

More recent studies, Maeder et al (Maeder, Ewanation & Monnink, 2016) explored the weight that jurors allocated to DNA compared to other forms of evidence. In this study participants read trial transcripts where either strong or weak DNA evidence was presented, with either strong or weak eye witness testimony that contradicted the the DNA evidence. They found that jurors weighted DNA analysis more highly than eyewitness testimony in every case, providing favourable verdict decisions for the party who presented the DNA (i.e., not-guilty if the DNA was presented by the defence and guilty if it was presented by the prosecution).

1.3. Evidence Complexity

Expert witnesses, who are the people who present forensic testimony at trial, have the important role of explaining forensic evidence to jurors. However, evidence complexity, how it is delivered, and the way it is explained impacts how jurors process the information and use it to reach a verdict (Cooper, Bennett & Skel, 1996; Lieberman et al., 2008).

As we have briefly discussed, evidence is mixed about whether jurors can accurately interpret forensic evidence. Cooper et al. investigated how complex bio-chemistry forensic testimony affected juror decision making. They found that jurors were more likely to rely on cues other than the testimony to determine the defendant's guilt when the science was complex. Later, Cooper and Neuhaus (Cooper & Neuhaus, 2000) conducted another study involving testimony about polychlorinated biphenyls (PCBs) and whether it has a proximal or causal relation to cancer. The two conditions in this study included a high-complexity testimony that contained technical and scientific jargon and a low-complexity testimony that contained more layperson's terms. They found again that in the high complexity condition participants had limited ability to comprehend and process the information, so jurors were more affected by heuristic cues, such as the credibility of the expert witness, than the testimony itself. In the low complexity condition participants were unaffected by heuristic cues. These findings could suggest that when jurors find the testimony cognitively challenging, jurors are likely to favour heuristic processing over systematic processing.

In contrast, other studies have found that, although juries may have some issues comprehending complicated forensic evidence, it was the strength of the evidence that swayed the participants verdict. The studies also found that judges generally agreed with most jury verdicts (Eisenberg et al., 2005; Hannaford-Agor, Hans, Mott & Munsterman, 2002; Heuer &

Penrod, 1994). This was found to be true regardless of whether the evidence presented in court was high or low in complexity (Eisenberg et al., 2005; Heuer & Penrod, 1994). This would suggest that, even if jurors do have some issues with comprehending the evidence, lack of comprehension does not lead to outcomes different to those of judges, who would have reasonably high forensic knowledge.

Case studies and studies that include interviews with jurors produce mixed evidence. A study found that jurors found that scientific, statistical, and technical expert witness testimonies were challenging to understand (Cecil, Hans, & Wiggins, 1991). Post-trial interviews with jurors who were asked to reach a verdict on a case that involved asbestos found that jurors misunderstood some of the evidence about how asbestosis develops. Lempert's (1993) review of 13 complex jury trials uncovered that he jury did make some mistakes and often did not fully comprehend the forensic evidence; however, this lack of comprehension was frequently due to problems in expert witness testimony, lawyer presentations, or jury instructions. However, Lempert concluded that despite low comprehension the juries usually reached a defensible verdict.

1.4. Education, Comprehension and Conviction

There has been some research investigating what factors affect juror's ability to understand complex evidence, and what affect comprehension has on conviction rate. Previous research has found that jurors who had completed a higher level of formal education, and studied more maths and science-based subjects, could better understand forensic testimony even if they had never been exposed to the specific information before (Weinstock, 2005). A longitudinal study on how experience in an undergraduate degree

affects reasoning (Lehman & Nisbett, 1990) also found that undergraduate education in science and humanities improved participants reasoning ability. This would suggest that those who are more highly educated, especially in science subjects, would be able to better comprehend forensic evidence and use it to reach a correct verdict.

Franklin Stier (Strier, 1997) reports that there is conflicting evidence about whether highly educated jurors are likely to convict, some studies noting greater tendency for better educated jurors to convict, whereas others found that in the few cases where education level seemed to influence verdict, in most cases the more educated jurors were less likely to convict.

Franklin Strier's paper suggested that to improve the jury system a more educated jury should be employed, where in complex cases 6 of the jury meet a minimum education requirement. He claimed this would improve accuracy of conviction as more educated jurors can better follow judicial instructions and piece together fragmented information.

1.5. Confidence

Some research has also been done to investigate how testimony complexity affects jurors' confidence that they made the right decision. It's been found that when a case is complex, increased quantity of information can decrease jurors' self-reported ability to understand trial information, and decrease their confidence (Heuer & Penrod, 1994).

1.6. Current study

The present study was designed to examine how testimony complexity affects the participants comprehension of the DNA evidence, as well if comprehension affects their verdict. We also explored if level of education, level of biology education, and ranking of forensic evidence reliability affected comprehension and verdict. Finally, we wanted to further explore how testimony complexity affects how confident participants are that they reached the correct verdict.

The study employed a single factor, between subjects' experimental design, manipulating the complexity of the DNA testimony. The three conditions were control (no DNA testimony), simple (simple DNA testimony) complex (complex DNA testimony).

From the literature reviewed, we developed several hypotheses. Note for these Hypotheses that in the stimulus materials for this study the expert witness will suggest the defendant is guilty. For further details see the method section and appendix A.

1.6.1. Hypothesis 1: Higher education, both biological and general, will result in higher comprehension scores.

1.6.2. Hypothesis 2: Comprehension scores will be highest in the simple condition

1.6.3. Hypothesis 3: Participants with a higher level of education will be more likely to convict

1.6.4. Hypothesis 4: Participants will be more confident that their verdict was right in the simple condition

1.6.5. Hypothesis 5: Lower comprehension scores will lead to more convictions

1.6.6. Hypothesis 6: More participants will find the defendant not-guilty in the simple condition (i.e., will not go with the opinion of the expert witness)

1.6.7. Most participants will rank DNA as the most reliable form of evidence

1.6.8. Those who ranked eye witness testimony as number one will be more likely to say not-guilty

2. Method

2.1 Ethics

The study was approved by The University pf Adelaide School of Psychology Human Research Ethics Subcommittee (approval number 18/66). Participants undertook the study anonymously and were free to withdraw at any time up until the point of submission. Consent was required from each participant before they could begin the experimental task, and participants indicated this consent by clicking 'next' on the relevant page.

2.2. Participants

The only eligibility criteria for this study was that the participants were over the age of 18. Participants were recruited by several methods. Posters were put up around the Adelaide University North Terrace Campus, in cafes around the suburb of Prospect, and the study was made available on the Research Participation Pool for students to access. A link to the survey was also sent to various Adelaide University Sports Clubs due to the student researcher's involvement in the University sporting community. A total of 287 people participated, but 17 sets of data were removed from analysis due to incorrectly answering the manipulation check question 'what was the name of the victim in the case summary?' or completing the task in under five minutes, indicating that they did not read the stimulus materials correctly.

Of the remaining 270 participants, 157 (58%) were female and 113 (42%) were male. A total of 90 were randomly assigned to the control condition (57 females, 33 males), 88 were randomly assigned to the simple condition (49 females and 39 males) and 92 were randomly assigned to the complex condition (51 females and 41 males).

The age range of the participants was between 18-73. The average age was 27 with a standard deviation of 9.01 years. The median age of participants was 23 and the mode was 21 years.

During the survey participants were asked to disclose their highest level of education. 0 participants had completed a PhD, 9 (3.3%) participants completed a master's degree, 163 (60.3%) participants completed a bachelor's degree, 75 (27.7%) participants completed year 12, 13 (4.8%) participants completed up to year 11, and 7 (2.5%) participants completed up to year 10.

They were also asked to disclose their highest level of biology education. 7 (2.6%) had completed third-year biology, 9 (3.3%) had completed second-year, 43 (15.9%) had completed first-year biology, 118 (43.7%) had completed year 12 biology, 20 (7.4%) had finished year 11 biology and 70 (25.9%) had finished year 10 biology.

Participants who were recruited via a poster were instructed to email the student researcher, who then sent them a document containing the consent form and participant information sheet (attached in appendix C and D), as well as a link to the survey. Participants recruited via the Research Participation Pool received a credit for their participation.

2.3. Materials and procedure

Participants' responses were collected through the online survey tool Survey Monkey. Participants had an average completion time of 18.13 minutes. At the beginning of the survey the participants were asked their age, gender, what is the highest level of education they have completed, and what is the highest level of Biology education they have completed, with options ranging from year 10 to PhD and year 10 to third year university respectfully. Participants were also asked to rank 5 kinds of forensic evidence, DNA, fingerprint analysis,

bite mark analysis, eye witness testimony and blood pattern analysis from 1-5 with 1 being the most reliable and 5 being the least.

After the initial set of questions participants were instructed to carefully read a summary of a crime, which was adapted from the stimulus materials used in a legal study by William C Thompson (Thompson, Kaasa & Peterson, 2013). These stimulus materials were chosen because in includes DNA evidence, contradicting eye witness testimony. The complex DNA testimony was adapted from a combination of the explanation of DNA from a UK based website ("The Forensics Library", 2018) and stimulus materials used in a previous study (Maeder, McManus, McLaughlin, Yamamoto & Stewart, 2016).

The case summary was the same in all three conditions and described a sexual assault in a woman's home in Adelaide. The summary describes that Mary Wilson is woken from sleep by a man in a mask sat on the end of her bed. The man holds and knife to her throat and proceeds to sexually assault her. Once the attack is over, the perpetrator enters the victim's bathroom and wipes his hands on a washcloth. He also appears to put a condom in a zip lock bag and then put it into his pocket. As soon as the man leaves the victim calls the police. Police arrive quickly and see a man near the victims back yard. He is questioned and identifies himself as Brian Kelly, the victims next door neighbour. He says he was not aware that Mary had been attacked, but he heard a noise and came out to investigate. He tells the Police Officer he had just gotten home from work. The Police Officer lets him go without searching his pockets. Police search Mary's bathroom and take the washcloth the attacker used in the bathroom into evidence. Mary is taken to hospital where a trained nurse takes swabs from her person to check for DNA. No DNA other than Mary's is found. Mary is later questioned at the Police Station and asked if she thinks her attacker could be Brian Kelly. She says no, as she believes she would recognise him if he was the. The summary also describes how Police visit Brian Kelly's work place that night (an On the Run approximately 15-minute drive from his house) to

corroborate that he was at work during the attack. There were no working cameras at the On The Run but his friend and supervisor tells Police he would testify in court that Brian left work just after midnight, so could not have possibly been the attacker. Police ask Brian Kelly for a sample of his DNA which he willingly gives. DNA analysis is done on the washcloth and finds that the biological material present belongs to Brian Kelly. He is arrested for the rape of Mary Wilson.

After reading the summary, participants were then asked to read the court room proceedings and the DNA testimony of an expert witness. The expert witness is highly educated and has 25 years' experience in the field. There were three levels of complexity of the DNA testimony, the 'control' condition where there is no description of DNA or how it was analysed, the 'simple' condition where there is a simple description of DNA and how it was analysed, and a 'complex' condition with a complex description of DNA and how it was analysed (similar to what would be presented in a real trial). In this case 'simple description' was defined by using less complicated language. For example, in the simple condition non-coding DNA is described as '*most of the human genome, about 75%, is made up bits of DNA that does not code for any proteins*' where as in the complex condition it is described as *'A significant amount of the human genome, approximately 75%, consists of extragenic DNA, which contains regions that do not code for known gene sequences'*. Another example of how the complexity was manipulated, in the complex condition electrophoresis is described as *'electrophoresis is essentially a method of separating molecules by their size through the application of an electric field, causing molecules to migrate at a rate and distance dependent on their size'* where as in the simple condition *it is described as 'the DNA samples are put onto a gel and an electric current is run through it. The negatively charged DNA moves down the gel towards the positively charged end of the gel.'*

An analysis in Microsoft Word showed that the simple condition has a Fleche readability score of 61.5 which is approximately a reading ability of someone in year 10. The complex condition has a Fleche readability score of 39.2 which is approximately a reading ability of someone at University level.

The expert witness states in all conditions that there is only a 1 in 1 trillion chance that the biological material belonged to anyone other than Brian Kelly. Finally, there is a cross examination of the expert witness by Brian Kelly's defence lawyer. He asks if it's possible he made a mistake in the analysis, but the expert witness assures he followed all the precautionary procedures correctly and laboratory proficiency studies found that errors only occur approximately 1 in 100,000 times.

After reading the expert testimony, participants were then asked three questions to assess how well they understood the DNA evidence. These questions were 'what is tandem repeat DNA?' 'How are two samples of DNA compared after electrophoresis?' and 'What is the purpose of performing PCR on a sample of DNA?' They were asked to answer each question in 1 or 2 sentences. After all data was collected the participants answers were coded on a 0-2 scale for each question, with a maximum comprehension score of 6 and a minimum of 0. An example of a 0 answer for the question 'How are two samples of DNA compared after electrophoresis' was '*…to determine whose DNA it is'* and an example of a 2-point answer was '*The purpose of performing PCR is to amply the amount of DNA so there is enough to conduct further analysis on.'* To test inter-rater reliability, the student researcher and another student from the cohort coded sampled of responses according to the coding protocol (in appendix B). The Cohen's Kappa was .82. There were no indications of systematic differences in rater's coding.

Finally, participants were asked whether they'd find the defendant, Brian Kelly, guilty or not-guilty of this crime. They were also asked to rate on a sliding percentage scale from 0-100 how confident they are that their verdict one was right one.

3. Results

To determine whether non-parametric or parametric tests should be used we conducted a Shaprio-Wilk test on the comprehension scores and the percentage confidence that the verdict was right. Both came back non-significant, which indicates the data is not normal, therefore non-parametric tests were used. All tests used a 0.05 significance level.

3.1 Was there a Difference in Verdict Between Each level of Complexity?

A chi-squared test was conducted to assess if there was a difference in verdict between the three conditions x^2 (2, 270), 15.765, p <.00. As the p value is less than .05, there is evidence that there is a significant difference. As shown in Table. 1 and Figure. 1, more participants reached a not-guilty verdict in the simple condition than in the control and complex conditions. This evidence supports hypothesis 6.

Table 1. The two tables below show the raw data for verdict in each group and the chi-squared table.

COMPLEXITY * VERDICT Crosstabulation

		Verdict		Total
Complexity		Not-Guilty	Guilty	
	Complex	30	62	
	Simple	49	39	
	Control	26	64	
Total		105	165	270

Chi-Square Test

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	15.756[a]	2	.000
Likelihood Ratio	15.619	2	.000
N of Valid Cases	270		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 34.22.

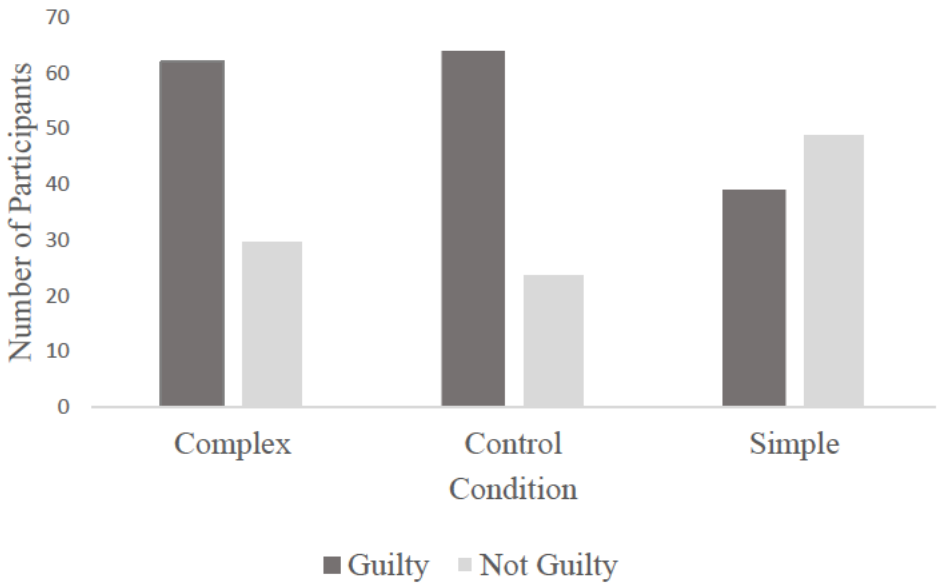

Fig 1. A histogram of the difference in verdict between each level of complexity. It shows that the control and complex condition show similar frequencies of each verdict, whereas the simple condition more participants found the defendant not-guilty.

3.2 What Factors Affected Comprehension?

We conducted several kinds of analysis to assess what factors affected participants comprehension of the DNA.

Firstly, we looked to examine if the complexity condition affected comprehension scores.

The mean score for comprehension was 1.01, (*SD* = 0.13) in the complex condition, 1.77, (*SD*= 0.18) in the control condition and 3.47 (*SD*= 0.19) in the simple condition. This indicates that participants in the complex and the control condition did not understand the DNA testimony as comprehensively as those in the simple condition. A Kruskal-Wallis test was conducted to see if the difference in comprehension score between each group was significant. The Kruskal Wallis yielded that there was a significant difference, ($H=78.54$, $p<0.00$). We did a Post Hoc analysis using a Dunn test and it showed that comprehension scores were significantly higher in the simple condition than the complex ($p<0.00$) and the control condition ($p<0.00$). The comprehension score was also significantly higher in the control condition than the complex condition ($p= 0.007$). This evidence supported hypothesis 2.

We predicted that participants with a higher education level in biology would have a higher comprehension score (hypothesis 1). The descriptive statistics showed that those who completed year 10 biology had a mean comprehension score of 1.25 and (*SD*= 1.32). Those who completed year 11 biology had a mean comprehension score of 1.91 and (*SD*= 1.79). Those who completed year 12 biology had a mean comprehension score of 1.96 and (*SD*= 1.81). Those who completed up to first-year University biology had a mean comprehension score of 3.21 and (*SD*= 2.03). Those who completed second-year University biology had a mean comprehension score of 3.44, (*SD* = 1.81*)*. Finally, those who completed up to third-year University biology had a mean comprehension score of 4.57, *(SD* = 1.90).

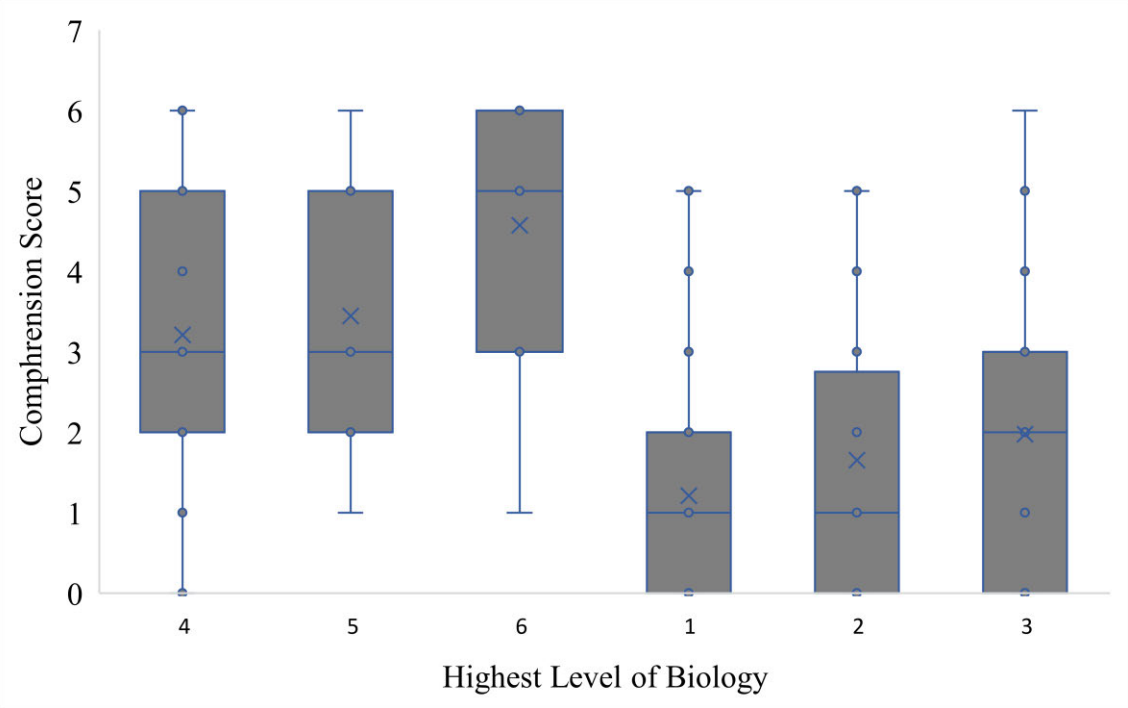

Fig 3. A boxplot showing the comprehension scores at each level of biological education. 1= year 10 biology, 2= year 11 biology, 3= year 12 biology, 4 = first year university biology, 5= second university year university biology, 6= third year university biology.

Looking at the descriptive statistics and Figure 3, it appears that as biology education increases so does the comprehension score. To test if this a statistically significant difference, we did a Spearman's' Rho test.

Table 3. Spearman's' Rho table showing a significant moderate correlation between level of biological education and comprehension scores. ** *indicates that Correlation is significant at the 0.01 level (2-tailed).*

			EDUCATION BIO	COMPREHENSION
Spearman's rho	EDUCATION BIO	Correlation Coefficient	1.000	.374**
		Sig. (2-tailed)	.	.000
		N	270	270

COMPREHENSION	Correlation Coefficient	.374**	1.000
	Sig. (2-tailed)	.000	.
	N	270	270

*Table 4. Spearman's' Rho table showing a significant moderate correlation between level of biological education and comprehension scores. ** indicates that Correlation is significant at the 0.01 level (2-tailed).*

The spearman's rho (Table. 4) revealed that there is a significant moderate correlation between level of biological education and comprehension scores, $r_s = .374$, $p < 0.000$. This would suggest that the higher the level of biological education, the higher the comprehension scores. This supported hypothesis 1. However, it should be noted that our sample had an uneven number of participants in each education group. We had 44 participants who completed up to first-year biology, 9 who completed second-year biology, 7 who completed Third year Biology, 69 who completed year 10 biology, 19 who had finished year 11 biology and the remaining 122 who completed year 12 biology.

Thirdly, we looked if levels of general education affected comprehension scores.

Table 4. Summary statistics of comprehension scores and level of Education

	Masters	*Bachelor*	*Year 12*	*Year 11*	*Year 10*
Mean	2.888	2.19	1.91	0.92	1.85
Median	3	2	2	1	2
Mode	0	0	0	1	4
Standard Deviation	2.66	1.96	1.70	0.86	1.68
Minimum	0	0	0	0	0
Maximum	6	6	5	3	4

Table 5. shows that comprehension scores are highest for participants who competed a masters, and lowest in those who completed year 11. Again, as with biological education, numbers in each group are uneven. To account for this we did a Mann-Whitney U test using

only the data from those who completed year 12 and those who completed a bachelor's degree, as these two groups were the closest in size (78 who completed year 12 and 163 who completed a bachelor's degree).

Table 5. Table of analysis of a Mann-Whitney U test comparing comprehension scores between those who completed Year 12 and those who completed a bachelor's degree. As the p=0.408 the difference was not significant

Bachelors		Year 12	
N:	163	N:	78
Mean rank:	83.546	Mean rank:	37.454
Mann-Whitn U :	5945.5		
z :	-0.82758	p (same med.):	0.40791
Monte Carlo permutation:	p (same med.):	0.4038	

(*) Statistically significant at $p < 0.05$

The Mann- Whitney indicated that there was not a significant difference in comprehension between those who completed year 12 and those who completed a bachelor's degree, U= 5945.4, p = 0.408. This data does not support hypothesis 1.

3.3 How did Ranking of Evidence Affect Verdict?

Before reading the case summary, participants were asked to rank five different kinds of forensic evidence, 'DNA', 'eye witness testimony', 'bitemark analysis', 'fingerprint analysis' and 'blood spatter analysis', from the most to the least reliable. Figure 4. shows a histogram of these rankings. It shows that most participants ranked DNA as the most reliable (ranked number 1) and bitemark analysis as the least reliable (ranked as number 5). Eye witness testimony was most frequently ranked at number 2. This supports hypothesis 7.

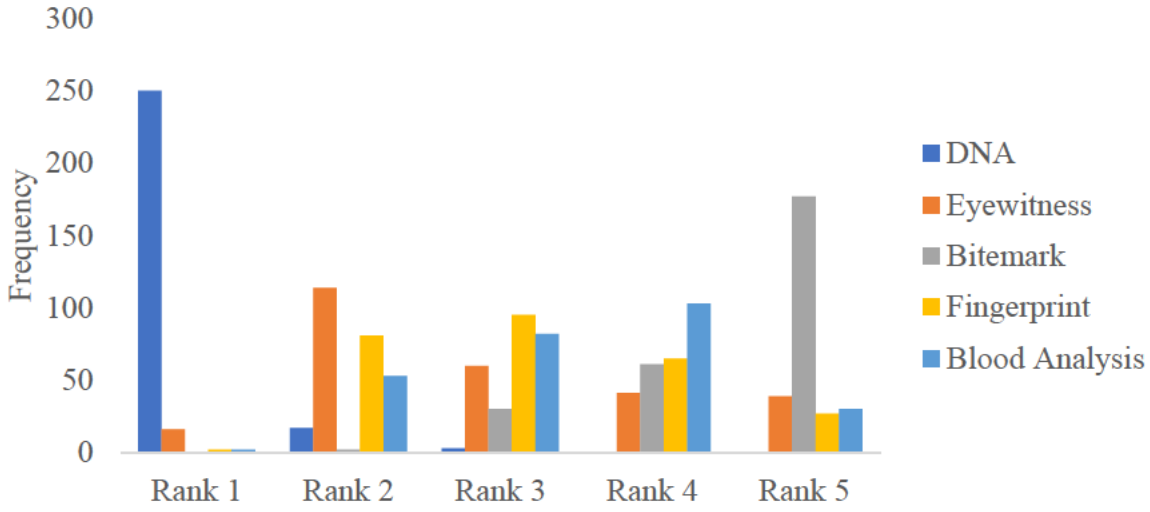

Fig 4. Histogram of participants ranking of the reliability of five different kinds of forensic evidence.

Due to the DNA evidence presented in the case summary, and how jurors have reacted to DNA in previous studies, we expected to see that if a participant ranked DNA as number 1 they were likely to say the defendant is guilty.

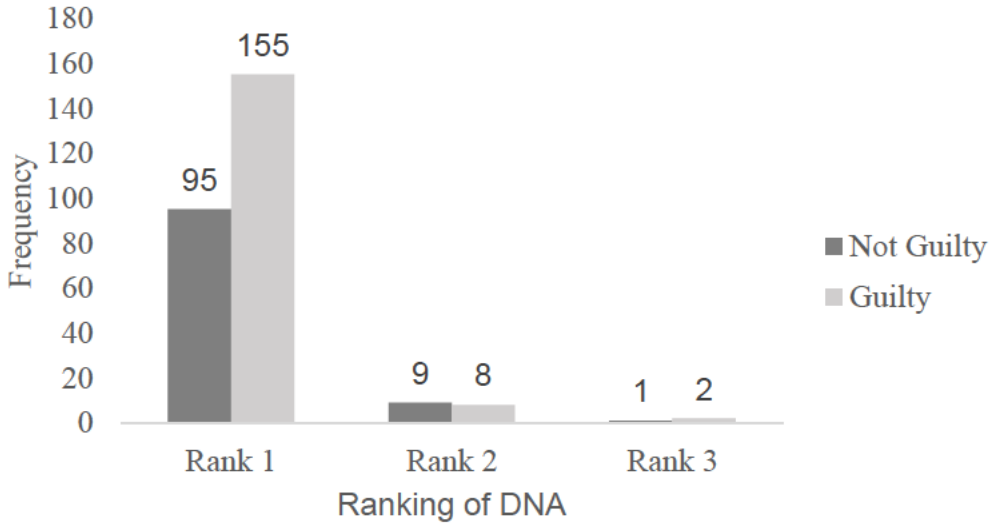

Fig 5. histogram to show what verdict participant chose and where they ranked DNA from 1-5. No participants ranked DNA lower than 3. The majority (155) ranked DNA a number 1.

The participants' responses showed that DNA was only ranked 1st, 2nd, or 3rd but most of the participants (93%) ranked it as number 1 (Figure. 2). For each rank, it is only when DNA was rank 2nd where there were more participants who found the defendant not-guilty, however this difference is only by 1. As seen in Figure. 5, 155 of 250 (62%) of the participants who ranked DNA as number 1 found the defendant guilty. This supports hypothesis 7.

The case summary also included some opposing eyewitness evidence. We explored how the ranking of eyewitness testimony affected the participants verdict.

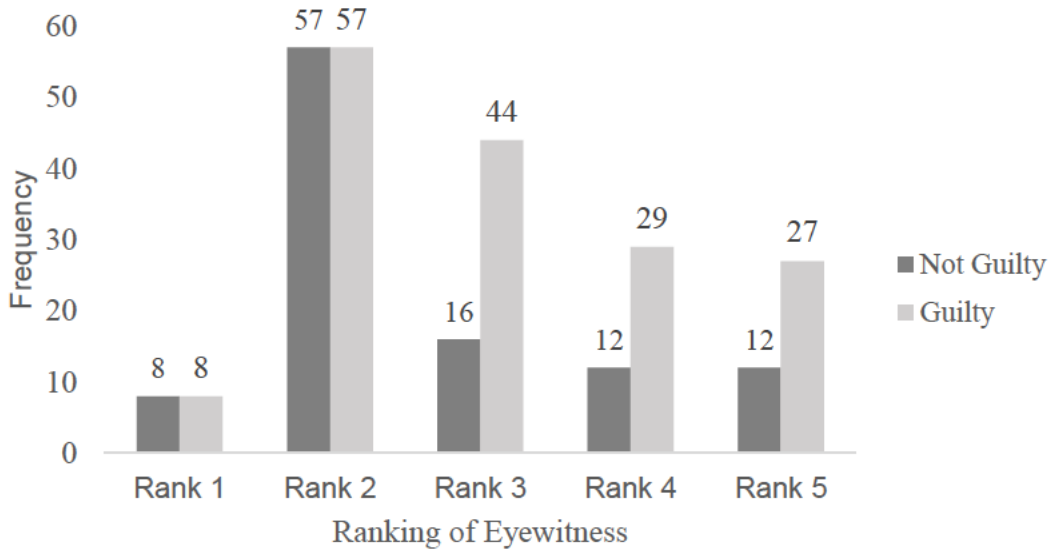

Fig 6. Histogram to show the frequency of participants that put eye witness testimony at each ranking.

In Figure 6. we can see that eye witness testimony was most frequently ranked as number 2 (57 participants). For those who ranked eye witness testimony either 1st or 2nd, there are an equal number who say guilty and not-guilty. However, when eyewitness testimony is ranked lower than 2nd, more participants found the defendant guilty. This shows some support for hypothesis 8.

3.4 How did Level of Education affect Verdict?

After establishing how education affects comprehension, explored if level of education affected the verdict.

As previously stated, the data is not balanced, however if we look at the proportions of guilty and not-guilty at each level of education (Figure 7.) we can see that year levels 10-12 have a similar distribution. In the bachelor and master's groups however, there is an increase in the number of participants that found the defendant guilty.

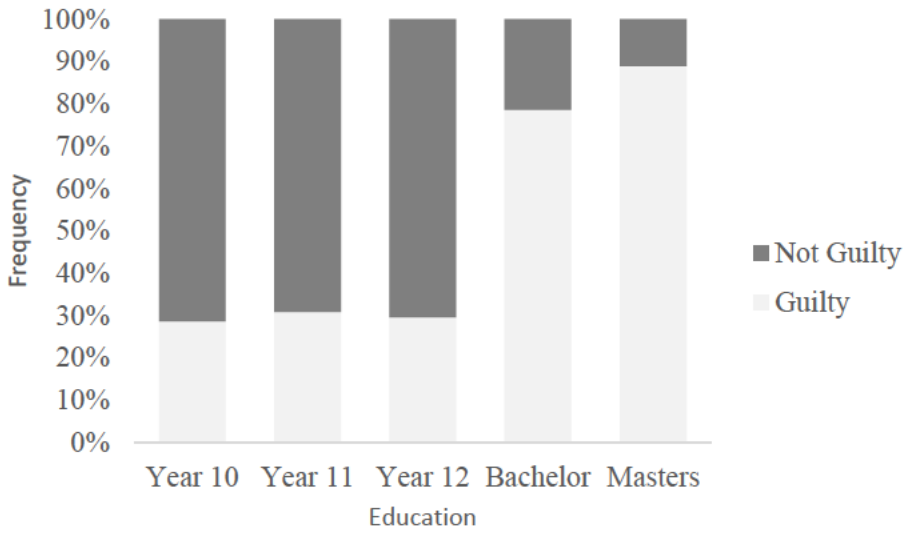

Fig 7. A histogram to show the percentage of participants that said guilty and not-guilty at each Education level

To test if this difference was statistically significant we ran a Chi-square test to see if the variables of education level of verdict are independent. This test was significant, X_2 (2) =15.76, p = 0.000379, V= 0.24. This would indicate that there is an association between the level of education and verdict. This supports hypothesis 3.

3.5 Did Comprehension Score Affect Verdict?

Figure 8 shows that most participants exhibited a low comprehension score. However, regardless of comprehension score, except for in the case of a score of 5, more participants found the defendant guilty. This would indicate that comprehension does not affect verdict, which does not support hypothesis 5. However, more participants scored low on comprehension that high, so this may have affected the results.

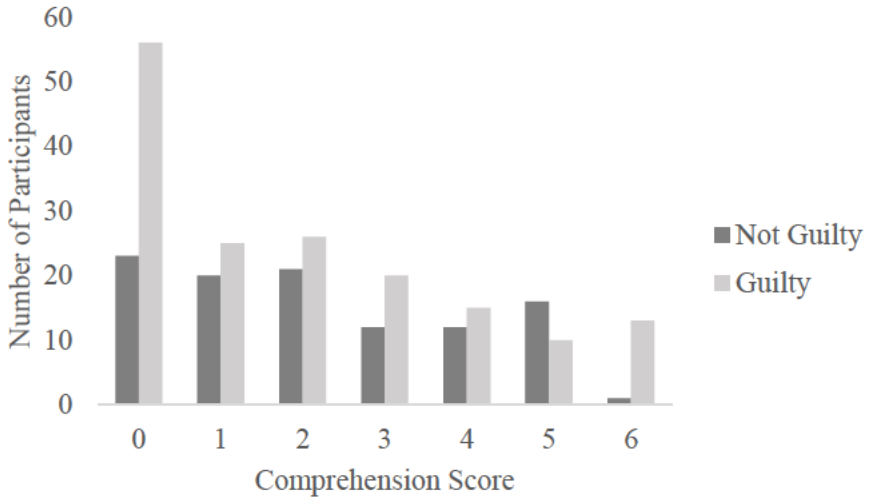

Fig. 8. A histogram that shows verdict at each comprehension score. It shows that regardless of comprehension score more participants found the defendant guilty than not-guilty

To explore the relationship more, we looked at the difference in verdict compared to comprehension score in each of the three complexity conditions separately

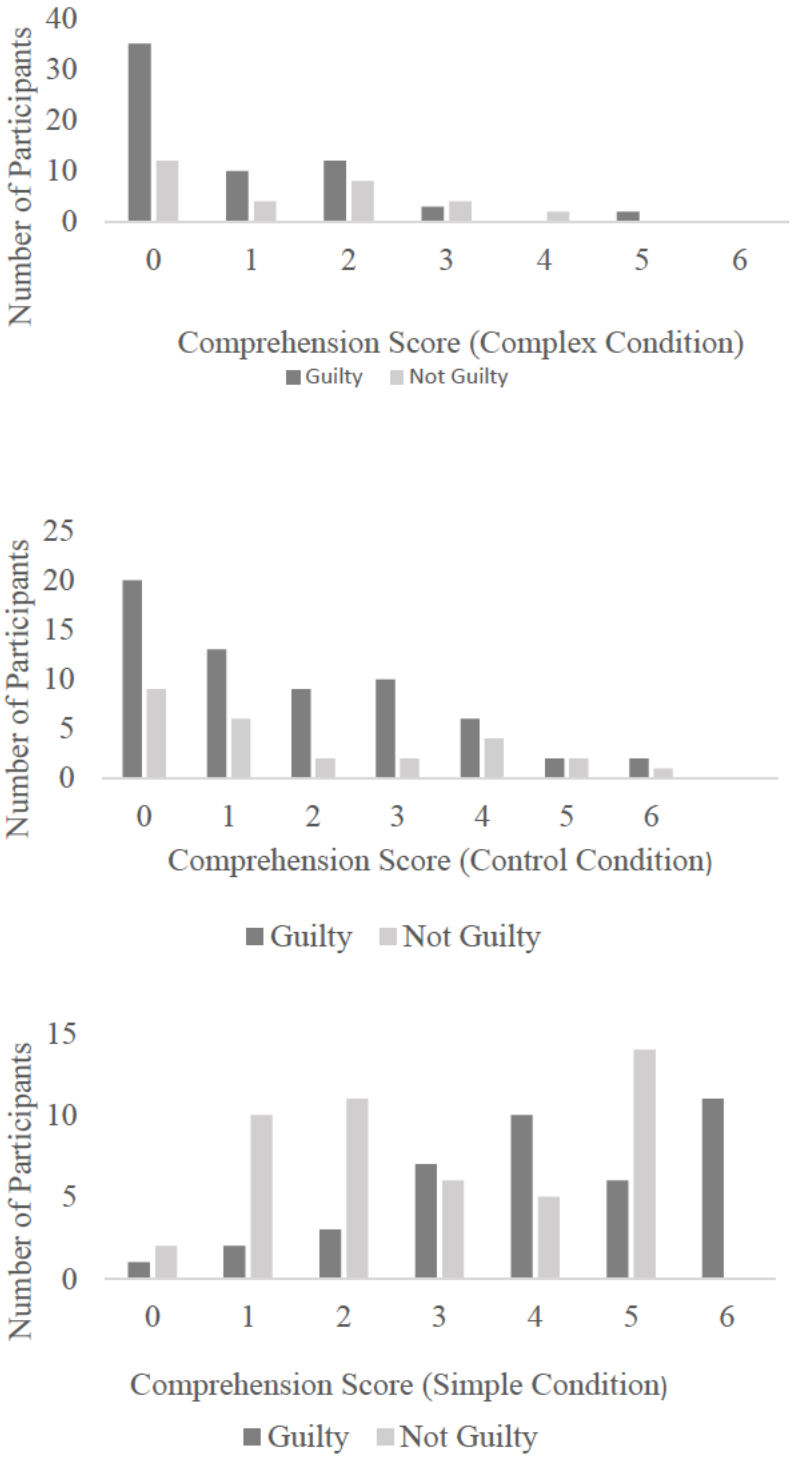

Fig 9. Three histograms that show what verdict participants chose compared to their comprehension score in the separate complexity conditions.

Figure 9. above shows that there was a similar relationship for those in the complex and the control condition. Most participants in these conditions scored low on the comprehension scale but regardless of comprehension found the defendant guilty. In the simple condition however, more participants scored highly on the comprehension scale and in all cases except for a comprehension score of 6 more participants found the defendant not-guilty. In the case of a score of 6 all participants found the defendant guilty.

3.6 Are Confidence Levels Affect by Complexity?

We explored if participants confidence level (expressed as a percentage) that their verdict was right was affected by the complexity condition.

Summary statistics are shown below in Table 6.

Table 6. Summary statistics of condition relative to percentage confidence that their verdict was right

	COMPLEX	CONTROL	SIMPLE
N	92	90	88
Min	2	3	0
Max	100	100	100
Mean	43.065	46.033	59.273
Stand. dev	25.446	24.097	23.734

Figure 10 shows that the average in the simple condition is higher than in the complex and the control conditions All three conditions have a similar range of responses.

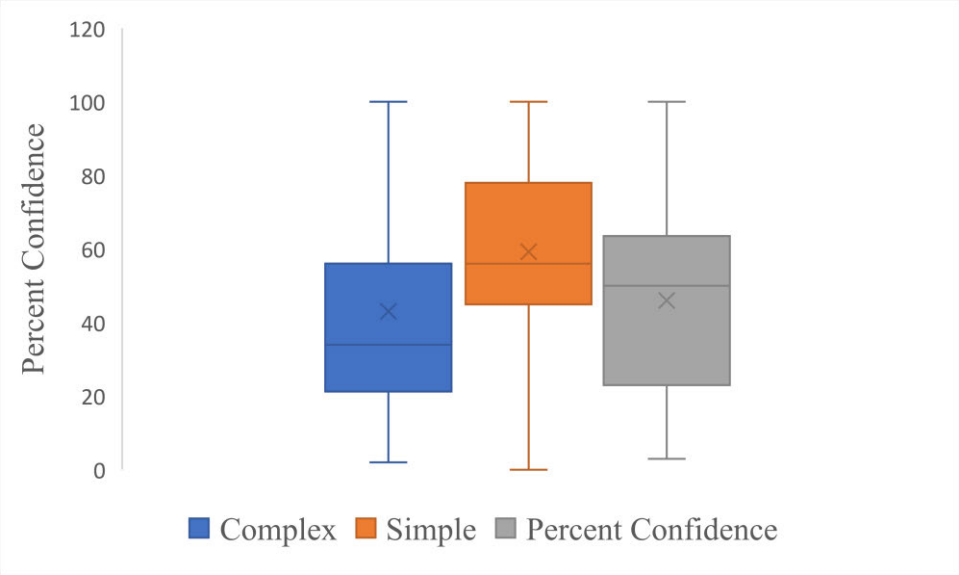

Figure. 10 A histogram of condition and percentage confidence that their verdict was the correct one

This could imply that the participants in the simple condition were more confident that their verdict was the correct one compared to the complex and control conditions.

To test this statistically we conducted an Kruskal-Wallis Test. We found a statistically significant difference (H=80.068, p=.00956) between complexity of the testimony and confidence that their verdict was correct. This shows supporting evidence for hypothesis 4.

We conducted a Post Hoc Dunn test to see where the significance was. It yielded that there was not a significant difference between the mean confidence scores in the complex and the control condition (p=.69) but there was between the simple and control (p<0.000) and simple and complex conditions (p<0.000). This means that the confidence level was higher in the simple condition than the complex and control conditions. This supports hypothesis 4.

3.7 Logistic Regression

Finally, we performed a logistic regression to see if any of the variables 'DNA rank position' 'eyewitness testimony rank position', 'level of education', 'level of Biology education', and 'comprehension score' had any effect on verdict.

Table 7. The three tables show the Omnibus Tests of Model Coefficients, the Model Summary, and the logistic regression table of 5 variables on verdict. All alpha levels are below 0.05 except for DNA ranking. Variables entered on step 1: EYEWITNESS (eyewitness testimony ranking), DNA (DNA ranking), COMPREHENSION (comprehension score), EDUCATIONBIOLAB (level of biology education), EDUCATIONLAB (level of general education)

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	77.117	5	.000
	Block	77.117	5	.000
	Model	77.117	5	.000

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	283.737[a]	.248	.337

a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	EYEWITNESS	.344	.136	6.391	1	.011	1.411
	DNA	.313	.449	.487	1	.485	1.368
	COMPREHENSION	-.299	.088	11.546	1	.001	.741

EDUCATIONBIOLAB	.553	.160	11.928	1	.001	1.738
EDUCATIONLAB	1.100	.262	17.583	1	.000	3.005
Constant	-5.592	1.148	23.727	1	.000	.004

Note: The dependent variable in this analysis is verdict coded so that 0 = not-guilty and 1 = guilty.

Results of the binary logistic regression indicate that there was a significant association between level of biology education, comprehension score, DNA ranking, eye witness testimony ranking, and level of general education, ($\chi 2(5) = 77.12$, $p < .00$). The binary logistic regression also tells us that somewhere between 25% and 34% of the variance in verdict is explained by the independent variables.

Table 7 shows that all variables except for the ranking of DNA have a significant effect on verdict. By looking at the unstandardized regression weight (B) we can see some notable results. If comprehension score decreases by .299 the participant is more likely to say guilty. We can also see that if level of education increases by 1.1 (so a year level increase) the participant is also more likely to find the defendant guilty.

4. Discussion

4.1. The Role of Education and Complexity in Comprehension

As we have discussed DNA testimony is often complex and difficult for jurors to understand (Cooper & Neuhaus, 2000). Franklin Stier (1997) argued that the jury system would be improved if a more educated jury was appointed, claiming that they are more likely to understand the testimony. Our study investigated if his claims were accurate.

We found that that was a moderate positive correlation between level of biological education and comprehension scores (Figure. 3). This support hypothesis 1. Participants who have studied biology at a higher level would have most likely studied DNA and how it is analysed in a detailed way. We can also presume they have been exposed to scientific papers and other difficult literature with low Fleche readability scores as part of their studies. Through this exposure they will have developed the ability to extract information from complex texts and process it more effectively than those who have not had the same exposure. Participants who completed up to year 10 biology had the lowest comprehension score. Those participants would not have studied DNA in as detailed a way, and they would not have developed the skills to be able to understand complicated scientific text. This evidence supports that those who have studied math or science at a higher level are more likely to be able to comprehend forensic evidence (Weinstock, 2005). It must be noted however that our data was not equal. Most of the participants had completed either year 12 or first-year biology, whereas only 9 and 7 had completed second-year or third-year biology respectfully. There was also a small number of participants who had completed year 11. This could mean that the data does not accurately represent the comprehension abilities of those in the years with smaller groups.

However, in disagreement with hypothesis 1 and Stier, we did not find a significant difference in comprehension score between those who had completed year 12 and those who had completed a bachelor's degree. We expected to find that participants who are generally more highly educated (not necessarily in biology) would have also had a higher comprehension score. Lehman and Nisbett (1990) found that those with an undergraduate degree had higher reasoning ability, however our data would indicate that reasoning ability does not translate to comprehension of complex scientific testimony, but instead may refer to a more highly developed ability to piece together information and make decisions.

We also investigated whether complexity of the testimony affected comprehension. In support of hypothesis 2 we found that those in the simple condition, where the language was simpler, and the Fleche readability score was higher, participants comprehension score was significantly higher. This would suggest that if testimony is presented in a way that is easier for the juror to digest, the jury are much more likely to understand the science.

The control condition and the complex condition both had similarly low average comprehension scores. The control condition did not have any DNA testimony, so participants were relying only on prior knowledge (if they had any) to answer the comprehension questions, so a low average was expected. Although, the average was significantly higher in the control than the complex. This could be due to more participants with high biology education being assigned to the control condition, so they would have known the answers without the DNA testimony. The complex condition used difficult scientific language, long sentences and had a low Fleche readability score. The result suggests that if DNA presented in court is too complicated for jurors to understand, then they do not comprehend the science any better than if it wasn't presented at all.

4.2. Role of Comprehension in Verdict

As well as assessing what factors affect comprehension, we also investigated whether comprehension affected the verdict. There has been some debate in the literature about whether a juror's ability to understand complex forensic testimony affects verdict (Hannaford-Agor, Hans, Mott & Munsterman, 2002; Heuer & Penrod, 1994).

A chi–squared revealed that in both the complex and control conditions, more participants found the defendant guilty whereas in the simple condition more participants found him not guilty (Figure. 1). This supported hypothesis 6. It has been theorized that when the testimony is too complex jurors rely on heuristic cues to decide on a verdict (Cooper & Neuhaus, 2000). In this case, using that theory, it could be argued that those in the complex condition, who had low comprehension scores, relied on the opinion of the experienced and highly educated expert witness, which was that the defendant was guilty, to make their decision. However, in the simple condition, where comprehension scores were higher, they were more likely to consider all aspects of the case. It is possible they believed the contradicting eye witness testimony, or they believed that the DNA sample could have been contaminated, therefore they found the defendant not-guilty. The control condition could be explained similarly to the complex condition. If the participants received no information about how the DNA was analysed the data suggests that they also trust the opinion of the expert witness.

We also looked at how comprehension scores affected verdict using the whole data set. Figure 8 showed that regardless of comprehension score participants were more likely to find the defendant guilty. This did not support hypothesis 5 as we expected to find that lower comprehension scores, due to relying on the heuristic cue of the expert witnesses' opinion, would be more likely to convict. Instead we found that even when comprehension scores were high participants still chose to convict.

However, due to uneven numbers of comprehension scores (i.e, many more participants scored 0 and 1 than 5 and 6) perhaps our data could not tell the whole story. The logistic regression did indicate that if comprehension score decreased by .299 the participant was more likely to say guilty

To further investigated this, we graphed the comprehension scores and verdict in the three conditions separately (Figure. 9). This revealed that the control and complex conditions had a similar pattern. In both conditions most participants had a low comprehension score but found the defendant guilty more often than not-guilty at all comprehension scores. In the simple condition however, more participants had higher comprehension scores but found the defendant guilty more often than not-guilty at all comprehension scores apart from a comprehension score of 6, where interestingly all 11 participants found the defendant guilty.

It appears from our data that there is a difference in the way participants make decisions about DNA evidence when the testimony is simple than when it is complex. It also shows that when DNA testimony is complex, jurors make similar decisions as to when it is not presented at all. This has interesting implications for how complicated forensic science should be presented, and perhaps even start a debate about what aspects of the science are necessary to present in court, if participants are making similar decisions when it is not present.

4.3. Role of Education in Verdict

We predicted that those who are more highly educated will be more likely to convict, as found by Franklin Stier (Strier, 1997) when he reviewed the literature. However, he also reviewed a study that claimed more educated jurors were less likely to convict. Our data agreed with the first study, which supported hypothesis 3. Participants that held a bachelor or master's

degree found the defendant guilty more often than not-guilty. Participants that had completed either year 10, year 11 or year 12 found the defendant not-guilty more often than guilty (Figure.7), and this difference was significant. The logistic regression found that an increase in one educational year level means the participant is more likely to say guilty.

This is an under researched area and there are conflicts in the literature. Currently there is no agreed upon theory for why more educated jurors would convict more. Studies have shown that more highly educated have higher levels of social trust, including trust in the legal system (Huang, van den Brink & Groot, 2010). It could be argued in this case that more highly educated participants agreed with the expert witness because they trust the system and would not expect someone with so much experience to make mistakes. This is up for debate however, and our data does not allow us to draw any solid conclusions. More work could be done to better understand the relationship between level of education and rate of conviction. If we improve our understanding of this relationship, we could better consider Franklin Stier's suggestion that 6 members of a jury should meet minimum education requirements.

4.4. Role of Forensic Evidence Ranking in Verdict

Our data supported hypothesis 7, like previous studies (Lieberman, Carrell, Miethe & Krauss, 2008), that participants found DNA the most reliable form of forensic evidence (Figure. 4). However, a logistic regression found that DNA ranking was not a predictor of verdict. 93% of the participants ranked DNA as the most reliable form of evidence. Furthermore, 105 participants (38%) found the defendant not guilty. This suggest that even when ranking DNA as the most reliable, some participants found the defendant not-guilty despite his DNA being found at the scene. Some participants contradicted their previous feelings about evidence after reading the case. This is an area that can be further researched, to

see if there is a link between previous ideas about forensic reliability and juror verdict and investigate what factors could cause a juror to contradict beliefs.

The logistic regression also showed that eyewitness testimony rank did influence verdict. To explain this, we graphed the ranking of eyewitness testimony and verdict. It showed that most people ranked eyewitness testimony as number 2, but there was an equal number of guilty and not-guilty verdicts when it was ranked 1 and 2 (Figure. 6). When eyewitness testimony was ranked lower than 2 there were increasing numbers of participants that found the defendant not guilty. This indicates that the lower eyewitness testimony was ranked, the more likely participants were to discard the contradicting eyewitness testimony and find the defendant guilty. This does not support hypothesis 8 as we predicted that those who ranked eye witness testimony first would be more likely to convict. It is possible that we do not see the trend because there was such a small number of participants who ranked eyewitness testimony as number 1.

4.5. Role of Complexity in Confidence

Finally, we explored how the complexity of the testimony affected juror's confidence that they made the correct verdict. We hypothesized (hypothesis 4) that confidence would be higher in the simple condition, as when the testimony is more complex jurors feel less confident in their verdict (Heuer & Penrod, 1994). Our data supported this. We found no difference in confidence in the complex and control conditions, but confidence was significantly higher in the simple condition (Figure. 10). Jurors who have lower comprehension and rely on heuristic cues to make decisions appear to be less confident in their verdict.

This is also another case where the control and the complex conditions show a similar pattern, further supporting that when DNA is too complex it has the same effect as if it wasn't there.

4.6. Limitations

There were several limitations in the design of this study. Firstly, the control condition was could have been designed in other ways. It would have been interesting to either have included a third level of complexity, or a control condition where the participant reads only the case summary and decides without reading the opinion of the expert witness. The former case would improve the study as we could have explored more deeply how complexity affects comprehension and verdict. The latter case we could investigated how jurors decide when they aren't given any expert opinions, which would have allowed to further explore how education and forensic ranking factors affected verdict.

The current control however did show us that jurors make similar decisions when the testimony is complex as to when its absent, which could perhaps start a discussion around what aspects of the science is necessary for the juror to hear.

Secondly, the study did not offer a way for participants to explain what element of the testimony influenced their decision. Without this it was difficult to make justifiable conclusions. To improve, another study could include a multiple-choice option of factors that affected verdict, or a text box so participants could write a few sentences to explain what influenced them.

The study was also limited by scope of participants. Most were either part of a sporting club at Adelaide University or a student at Adelaide University. Therefore, results may only be

generalisable to one community. As mentioned previously there were also uneven groups for education levels, comprehension scores, and ranking positions, which was also a limitation.

4.7 Areas for Further research

Despite limitations, this study has highlighted several areas where more research could be done. More research could be done to develop theories as to why (or why not) more educated jurors are more likely to convict. More research could also be done to better understand how previous ideas about DNA (or other forensic sciences) reliability may influence verdict, and what factors may cause someone to make a decision that contradicts those previous ideas. We could also further explore what level of previous biology education is necessary for a jury to fully comprehend forensic testimony, and whether high comprehension is necessary to make a reasonable decision on verdict.

4.8. Conclusions

The study demonstrated that those more educated in biology only have a higher comprehension score and we found that more educated jurors convict more frequently. Our study supported that when testimony is complex participants are more likely to trust the opinion of the expert witness and make decisions based on heuristic cues. We found similar patterns of comprehension and conviction in the control and complex group, possibly indicating that when DNA testimony is too complex jurors will make the same decisions as if it wasn't presented at all.

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APPENDIX A: STIMULUS MATERIALS

SUMMARY OF THE CASE

At 12:45 am on March 1, 2015, an Adelaide resident named Mary Wilson called a “000” operator to report that she had been sexually assaulted in her home. Police officers arrived at Mrs. Wilson's house within two minutes of the 000 call.

The first officer on the scene observed a man wearing dark clothing in the side yard between the Wilson house and the house next door. The officer detained and questioned this man, who identified himself as Brian Kelly.

Mr. Kelly said that he lived next door to Mrs. Wilson. He said that he worked at an On the Run (OTR) garage and had just arrived home from work. He said he had gone into the side yard to investigate a noise he had heard after getting out of his car, which he had just parked in the driveway. He said he was not aware of the attack on Mary Wilson. After checking Kelly's identification and verifying that he lived next door to Mrs. Wilson the Adelaide Police officer released Kelly and allowed him to enter his own house. He did not search Kelly's person or ask Kelly to empty his pockets.

Six other officers from the Adelaide Police Department conducted a search of the surrounding area but found no one else outside and found no evidence related to the crime.

Meanwhile, a detective from the Adelaide Police Department interviewed Mrs. Wilson. She said she had gone to bed early that evening but was awakened suddenly when a man sat down on her bed and held a knife to her throat. She said she could not see the man well because it was dark in the room and he was wearing a mask, but she thought he had a dark complexion and black hair. She said the man was very big and heavy and that his breath smelled of alcohol. His speech was slurred as if he was drunk and she said he had a very deep voice. According to Mrs. Wilson, the man was in her house for about 45 minutes. She recalled noticing that her bedside clock read 12:01 shortly after the man woke her.

Mrs. Wilson said the man had forced her to have sexual intercourse. He then ordered her not to move while he went into her bathroom, where she heard him running water in the sink and flushing the toilet. She said when he came out of the bathroom he was holding something that she thought was a condom, which he placed in a plastic zip

lock bag. He put the bag in the pocket of his jacket. She said the man ordered her to say nothing about the attack. She heard him leave the house through the back door. She immediately called “000” to report the attack.

The detective asked Mrs. Wilson if she thought she would recognize the man if she saw him again. She said she wasn't sure because it had been so dark that she hadn't seen his features clearly. The detective asked Mrs. Wilson whether her assailant could have been her next-door neighbour, Brian Kelly. She responded, “No, of course not. I would have recognized him.” She said her assailant was bigger than Mr. Kelly and had a deep voice, while Mr. Kelly has a higher pitched voice.

To check whether Brian Kelly could be ruled out, the detective asked Kelly to provide a sample for DNA analysis. Kelly voluntarily provided a sample the next day.

The detective also checked Kelly's activities the night of the crime. He found that Kelly had worked a 4 pm to midnight shift at an OTR approximately fifteen minutes’ drive from his home. Kelly's supervisor verified that Kelly had worked his shift that evening. According to the supervisor, Kelly had left work shortly after midnight. The supervisor, a close friend of Mr Kelly’s, offered to testify under oath that Kelly had left work after midnight. The ‘clock off’ system at OTR to indicate an employee had finished their shift was done by signing out on a piece of paper, not electronically. The clock off sheet for that evening said Kelly finished work at 12.02. There were cameras operating at the OTR but due to a fault they had not been recording for two weeks, so Kelly’s whereabouts could not be confirmed via video footage.

Kelly is 5′7″ tall and weighs 155 lbs. His voice is relatively high pitched for a man. He has light brown hair, blue eyes, and has a light complexion.

Mrs. Wilson was taken to a hospital where a trained Sexual Assault Nurse Examiner collected biological samples from her body. The nurse reported bruising and other evidence of trauma. However, none of the biological samples contained semen. DNA testing showed no evidence of DNA from anyone other than Mrs. Wilson herself. A sample collected from Mrs. Wilson showed traces of the chemical nonoxynol, which is a spermicidal agent found on many condoms.

A technician from the crime laboratory found a damp washcloth on the floor of Mrs. Wilson's bathroom. The technician knew that human DNA in the form of dead skin cells can sometimes be picked up on washcloths, so the technician sent it to the laboratory for DNA analysis.

The laboratory reported finding a male DNA profile on the washcloth that was an exact match with the DNA profile of Mr. Kelly. When questioned by police, Mr. Kelly denied that he had ever been in Mrs. Wilson's house and denied that he had ever touched one of her washcloths. Mrs. Wilson agreed that, to her knowledge, Mr. Kelly had never been in her house and could not have had contact with her washcloth, unless he was the rapist.

Due to this forensic evidence he is charged with the rape of Mary Wilson.

EXPERT WITNESS TESTIMONY

NO DETAIL CONDITION (CONTROL)

Later, in court, an expert from Forensic Science SA Sam Gale, who conducted the DNA tests in the lab testified on behalf of the prosecution.

During his testimony Sam first explained what DNA is and then how DNA samples are collected and analysed in the laboratory.

HIGH DETAIL CONDITION (COMPLEX)

Later in court, an expert from Forensic Science SA Sam Gale, a graduate of Oxford University in the UK with 25 years' experience in the field, testified on behalf of the prosecution.

During his testimony Sam first explained what DNA is and how DNA samples are collected and analysed in the laboratory.

'…DNA is essentially the molecule that holds all genetic information for building an organism. The human genome is composed of over 3 billion base pairs of information organised into 23 chromosomes. Genes are the regions of DNA that encode and regulate protein synthesis, though this involves only 1.5% of the entire genome. A significant amount of the human genome, approximately 75%, consists of extragenic

DNA, which contains regions that do not code for known gene sequences. About 50% of extragenic DNA is made up of tandem repeat DNA, which is useful in forensic DNA analysis. Tandem repeat DNA and the variation in its size and sequence in different people, known as polymorphisms, is the focus of many DNA profiling techniques including PCR and electrophoresis, which are the ones I used in this case. It is the difference in number and location of these polymorphisms in tandem repeat DNA that produces a distinctive 'DNA fingerprint', that is totally unique to an individual.

For this case, I collected the biological material from the washcloth found at the crime scene. The amount of biological material present was very small and not enough to perform any analysis on, so first I performed a Polymerase Chain Reaction. PCR is a technique which allows for the exponential amplification of DNA fragments. This is done by extracting the DNA from the biological material and spinning in a centrifuge, followed by incubation in optimal conditions for the reaction. A reaction mix is prepared and kept on ice until the sample is ready to be denatured at 95°C for 30 minutes to break apart the double helix into two single helical strands. This process is followed by annealing the fragments at their optimal temperature to produce hydrogen bonding between complimentary sequences to produce a double-stranded polynucleotide. The sample is then incubated again before cooling. This method will produce two complete daughter strands from a single DNA fragment, amplifying the amount of sample available for testing.

After PCR we use a technique called electrophoresis to produce the distinct 'DNA fingerprint'. Electrophoresis is a method of separating molecules by their size through the application of an electric field, causing molecules to migrate at a rate and distance dependent on their size. In gel electrophoresis, a porous gel matrix is used, often consisting of agarose gel for simple work or polyacrylamide gel for more specific procedures. For this case I used polyacrylamide gel. The gel floats in a buffer solution to ensure the pH level is maintained and the applied electric current is conducted. Samples to be analysed are placed in small wells at the top of the gel using pipettes. A control sample and a marker sample were run simultaneously, as well as the sample Mr Kelly provided to Police. As the electric current is applied DNA, which has a negative charge, begins to move through the gel towards the positively charged anode. The gel acts as a type of molecular sieve, allowing smaller molecules to travel

faster than larger fragments. Following electrophoresis, to visualise the bands, a fluorescent dye was added. Electrophoresis not only separates DNA but also allows for the fragments to be measured. Measuring the size of these fragments can ultimately allow the number of repeats to be determined and thus the genotype at that locus. The washcloth sample and the sample Mr Kelly provided was analysed at the same time and the DNA fingerprint of both samples were measured and compared to determine if the biological material found on the wash cloth belonged to Mr Kelly.

Sam Gale then testified the probability, according to his forensic analysis, that the sample provided by Mr Kelly matched that of the biological material on the washcloth.

'…The analysis concluded that there is a 1 in 1 trillion chance that a randomly chosen man, other than Brian Kelly, would have the same DNA profile as that found on the washcloth. Because there are only 6 or 7 billion people currently alive, and only approximately half of them are male, and considerably less could entered Miss Wilson's home, it is unlikely that anyone other than Mr. Kelly left the biological material on the washcloth.'

LOW DETAIL CONDITION (SIMPLE)

Later in court, an expert from Forensic Science SA Sam Gale, a graduate of Oxford University in the UK with 25 years' experience in the field, testified on behalf of the prosecution.

During his testimony Sam first explained what DNA is and how DNA samples are collected and analysed in the laboratory.

'…DNA is the molecule that holds all genetic information and 'instructions' for building a person, plant or animal. Genes are the regions of DNA that hold the information that makes proteins, which are the building blocks that make a person, plant or animal. Genes only make up just 1.5% of the entire genome. Most of the human genome, approximately 75%, is made up bits of DNA that does not code for any proteins. About 50% this non-coding DNA is made up of something called tandem repeat DNA, which is what we test in forensic DNA analysis. Every person has a different sequence of Tandem repeat DNA, which are all different sizes and patterns, so we can compare a sample of DNA from a crime scene to DNA from a suspect to see if they match.

For this case, I collected the biological material from the washcloth found at the crime scene. The amount of biological material present was very small and not enough to do any testing on, so first I performed a Polymerase Chain Reaction. PCR is a technique used to make more of a DNA sample. Once I had done this I had enough DNA to analyse.

The method I used to analyse the DNA is called electrophoresis. This is when the DNA is separated according to its size. The DNA samples are put onto a gel and an electric current is run through it. The negatively charged DNA moves down the gel towards the positively charged end of the gel. The smaller DNA pieces move faster down the gel. In order to see the bands, I added a fluorescent dye. The size of these bands were measured, giving us a DNA fingerprint that we can compare. I ran the electrophoresis on the washcloth sample and the sample provided by Mr Kelly then compared the two DNA fingerprints to see if the biological material on the washcloth.

Sam Gale then testified the probability, according to his forensic analysis, that the sample provided by Mr Kelly matched that of the biological material on the washcloth.

'…The analysis concluded that there is a 1 in 1 trillion chance that a randomly chosen man, other than Brian Kelly, would have the same DNA profile as that found on the washcloth. Because there are only 6 or 7 billion people currently alive, and only approximately half of them are male, and considerably less could entered Miss Wilson's home, it is unlikely that anyone other than Mr. Kelly left the biological material on the washcloth.'

CROSS EXAMINATION (ALL CONDITIONS)

A lawyer hired by Mr. Kelly challenged the accuracy of the DNA test. He raised the possibility that there had been an *accidental transfer* of DNA in the laboratory. An *accidental transfer* means that some of the DNA provided by Mr Kelly could have ended up in the sample of biological material from the washcloth found at the crime scene.

In a cross examination of Sam Gale, Mr Kelly's lawyer said

'… as both the reference sample and the DNA sample from the washcloth were examined in the same laboratory. Would you say there is a possibility that DNA from Mr. Kelly's reference sample might have accidentally been transferred to one of the washcloth samples while the samples were in the laboratory?'

In response, Mr Gale said

"… as part of our standard laboratory procedure, all of the samples from a case are processed together in a batch. Although it is theoretically possible for DNA to be transferred accidentally from one sample to another in the same batch, the chances of this occurring in this case are very low due to laboratory protocols and procedures put in place to prevent this. I followed all these procedures correctly. In laboratory proficiency studies in which thousands of samples were tested the frequency of such errors has approximately 1 in 1,000,000."

QUESTIONS BEFORE THE SURVEY

1. Age
2. Gender (option to not disclose)
3. Highest level of education (did not complete high school, year 10, year 11, year 12, bachelor's degree, master's degree, PhD)
4. Highest level of education in biology (year 10, year 11, year 12, first year university, second year university, third year university)
5. How reliable would you consider these types of evidence? Please rank them in reliability, with 1 being the most reliable and being the least (DNA, finger print, blood stain analysis, eye witness testimony, bite mark analysis)

QUESTIONS AFTER THE SURVEY

COMPREHENSION

Please answer in one or two sentences

1. What is the purpose of performing PCR on a sample of DNA?
2. What is tandem repeat DNA?

3. How are two samples of DNA compared after electrophoresis?

GUILT AND CONFIDENCE

1. How do you find the defendant? Guilty (1) Not guilty (2)

2. Please use the slider to indicate your answer (in %)
   How probable is it that the accused committed the crime? (1)
   How certain are you that your verdict is the correct one? (2)

APPENDIX B CODING PROTOCOL

CODING FOR 'COMPREHSION OF DNA' QUESTIONS

What is the purpose of performing PCR on a sample of DNA?

- **2 points – the participant shows complete comprehension**
  To earn a score of 3 points the participants must state that PCR is used to amplify (also accepted 'make more of', 'duplicate' etc) the DNA **and** also state that this is so there is enough material to conduct further analysis on.

  Example of a 2 point answer
  The purpose of performing PCR is to amply the amount of DNA so there is enough to conduct further analysis on.

  PCR is a process used to create more of the DNA so there is enough to test

- **1 points – the participant shows some comprehension**
  To earn 2 points the participant must state that PCR is used to amplify (make more of, duplicate etc) the DNA. **OR** that it is used so that there is enough material to conduct further analysis on.

  Examples of a 1 point answer
  Amplifies the data

  So there is enough material to do other tests on

- **0 point – the participant shows no comprehension**
  To earn a score of 1 point participants will **not** mention that PCR is used to amplify DNA or that it is done so there is enough material to conduct further analysis on. Leaving the box blank is or saying 'I don't know' also a 1 point answer

  Examples of a 0 point answer
  To determine whose DNA it is

  To analyse the DNA

What is Tandem Repeat DNA?

- **2 points – the participant shows complete comprehension**
  To earn a score of 3 points the participants must state that tandem repeat DNA is the 'non-coding' part of the genome (also accepted 'does not code for proteins' or 'is part of extrogenic DNA' etc) **and** its polymorphisms (or differences, uniqueness etc) is what makes each person's DNA unique.

  Example of a 2 point answer
  Tandem repeat DNA is DNA that does not code for proteins and it is unique in every person

  Tandem repeat DNA is the part of DNA that is different in every person so is used for DNA analysis. It is also non-coding DNA.

- **1 points – the participant shows some comprehension**
  To earn 2 points the participant must state Tandem repeat DNA is the 'non-coding' part of the genome (also accepted 'does not code for proteins' or is 'part of extragenic DNA' etc) **OR** that Tandem repeat DNA is the part of DNA that is unique in every individual

  Examples of a 1 point answer
  The unique part of DNA

  Tandem repeat DNA does not code for proteins

  Part of extragenic DNA

- **0 point – the participant shows no comprehension**
  To earn a score of 1 point participants will **not** mention that tandem repeat DNA is the 'non-coding' part of the genome or that and its polymorphisms (or differences) is what makes each person's DNA unique. Leaving the box blank is or saying 'I don't know' also a 1 point answer

  Examples of a 0 point answer
  Tandem repeat DNA is used in many forensic analysis techniques

  DNA used to compare two people

How are two samples of DNA compared after electrophoresis?

- **2 points – the participant shows complete comprehension**
  To earn a score of 3 points the participants must state that electrophoresis separates DNA fragments into different sizes (using the word 'fragments' is sufficient) and that smaller fragments move further (or faster) down the gel. **AND** they must also state that after electrophoresis the size (or length) of these fragments are measured to create a DNA

fingerprint which is compared to other samples. Just stating that the DNA fingerprints were compared without mentioning that the fragments are measured is not sufficient.

Example of a 2 point answer
The DNA fragments are separated using electrophoresis, with the smaller fragments moving further down the gel. The fragments are then measured to create a DNA finger print which can then be compared against other samples.

Smaller fragments of DNA move further down the gel which separates them. The fragment sizes are measured and then compared to other samples.

- **1 point – the participant shows some comprehension**
  To earn 2 points the participant must state that electrophoresis separates DNA fragments into different sizes (using the word 'fragments' or 'separates' is sufficient) and that smaller fragments move further (or faster) down the gel **OR** that after electrophoresis the size (or length) of these fragments are measured to create a DNA fingerprint which is compared to other samples. Just stating that the DNA fingerprints were compared without mentioning that the fragments are measured is not sufficient.

  Examples of a 1 point answer
  The fragment sizes are measured creating a DNA fingerprint to compare

  The smaller bits of DNA move further down the gel

- **0 point – the participant shows no comprehension**
  To earn a score of 1 point participants will **not** mention that electrophoresis separates DNA fragments into different sizes and that smaller fragments move further (or faster) down the gel OR that after electrophoresis the size (or length) of these fragments are measured to create a DNA fingerprint which is compared to other samples. Leaving the box blank is or saying 'I don't know' also a 1 point answer

  Examples of a 0 point answer
  Visually with a dye

  The DNA fingerprints are compared

APPENDIX C PARTICIPANT INFORMATION SHEET

PARTICIPANT INFORMATION SHEET

PROJECT TITLE:
HUMAN RESEARCH ETHICS COMMITTEE APPROVAL NUMBER: [redacted]
PRINCIPAL INVESTIGATOR: Carolyn Semmler
STUDENT RESEARCHER: Megan Tomlinson
STUDENT'S DEGREE: Honours Degree in Psychology

Dear Participant,

You are invited to participate in the research project described below.

What is the project about?
Forensic evidence is an important part of criminal trials and, due to exposure to crime shows, many people over estimate how valid and reliable forensic evidence is. DNA evidence, although one of the most valid forms of forensic science, can still be misleading or contaminated, leading to the possibility of false convictions This research project aims to explore how jurors make decisions when presented with forensic evidence. This could aid in developing guidelines for expert witnesses, lawyers, judges and Police in how to present forensic evidence in court. This, in turn, could lead to fewer false convictions.

Who is undertaking the project?
This project is being conducted by Megan Tomlinson.
This research will form the basis for the degree of Honours of Psychology at the University of Adelaide under the supervision of Dr Carolyn Semmler

Why am I being invited to participate?
You are being invited as you meet the criteria for the study (you are eligible for jury duty in Australia)

What am I being invited to do?
You are being invited to complete a survey online.

How much time will my involvement in the project take?
Completion of this survey will take approximately 15-20 minutes of your time.

Risks associated with participating in this project?

There will be no risks to your physical or mental health by partaking in this project.

What are the potential benefits of the research project?
This research may result in a better understanding of how jurors make decisions surrounding forensic evidence and this in turn could lead to more useful guidelines for lawyers, judges and expert witnesses when presenting forensic evidence in court.

Can I withdraw from the project?
Participation in this project is completely voluntary. If you agree to participate, you can withdraw from the study at any time up until the submission of the survey online.

What will happen to my information?

Participants information will remain anonymous throughout the entire research process. No single person's data will be traceable from what will be published. The data collected will be used in Megan Tomlinson's Honours thesis. A summary of the results will be sent to any participant who wishes to receive it.
Your information will only be used as described in this participant information sheet and it will only be disclosed according to the consent provided, except as required by law.

[redacted]

What if I have a complaint or any concerns?
The study has been approved by the Sub Committee of Human Research Ethics Committee at the University of Adelaide (approval number 18/66). This research project will be conducted according to the NHMRC National Statement on Ethical Conduct in Human Research (2007). If you have questions or problems associated with the practical aspects of your participation in the project, or wish to raise a concern or complaint about the project, then you should consult the Principal Investigator. If you wish to speak with an independent person regarding concerns or a complaint, the University's policy on research involving human participants, or your rights as a participant, please contact Professor Paul Delfabbro on;

Email	paul.delfabbro@adelaide.edu.au
Telephone	**(08) 8313 4936**
Location	The University of Adelaide, Floor/Room 5 06, Hughes Building, North Terrace Campus

Any complaint or concern will be treated in confidence and fully investigated. You will be informed of the outcome.

If I want to participate, what do I do?

Complete and submit the online survey.

Yours sincerely,
Dr Carolyn Semmler
Megan Tomlinson

APPENDIX D CONSENT FORM

Human Research Ethics Committee (HREC)

THE UNIVERSITY of ADELAIDE

CONSENT FORM

1. I have read the attached Information Sheet and agree to take part in the following research project:

Title:	Does the experience of the expert witness or comprehension of the science effect juror's decision of guilt?
Ethics Approval Number:	[redacted]

2. I have had the project, so far as it affects me, and the potential risks and burdens fully explained to my satisfaction by the research worker. I have had the opportunity to ask any questions I may have about the project and my participation. My consent is given freely.

3. Although I understand the purpose of the research project, it has also been explained that my involvement may not be of any benefit to me.

4. I agree to participate in the activities outlined in the participant information sheet.

5. I understand that as my participation is anonymous I am free to withdraw from the project at any time up until the submission of the survey

6. I have been informed that the information gained in the project may be published in a thesis

7. I have been informed that in the published materials I will not be identified and my personal results will not be divulged.

8. I agree to my information being used for future research purposes.
   Yes ☐ No ☐

9. I agree to my information to be shared on an online digital repository.
   Yes ☐ No ☐

10. My information will only be used for the purpose of this research project and it will only be disclosed according to the consent provided, except where disclosure is required by law.

11. I am aware that I should keep a copy of this Consent Form, when completed, and the attached Information Sheet.

Participant to complete:

Name: _____ Signature: _____

Date: _____

APPENDIX E POSTER

THE UNIVERSITY of ADELAIDE

We are looking for people to read a summary of a trial and testimony from an expert witness, then answer some questions about DNA evidence and decide if you think the defendant is innocent or guilty

Time: Estimated time 15-20 minutes

Risks: There are no immediate risks to your health of safety in completing this study. It can be done on any computer in any place. However, the trial does contain facts about a sexual assault. If this is likely to cause any distress to you, we advise you consider not participating in this study.

Privacy: The data collected will be treated with utmost confidence. It will be stored on password protected computers. You will be able to withdraw from the study at any point up until you submit the survey. After submission your information will be de-identified and there will be no way to identify an individual's data. You will have the opportunity to submit your email address and receive the results of this study once its completed if you so wish!

Human research ethics committee approval number: #

Principle investigator: Dr Carolyn Semmler

Student researcher: Megan Tomlinson

Student's degree: Honours in psychology

This study has been approved by the University of Adelaide Human Research Ethics Committee