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Can science comics aid lay audiences' comprehension of forensic science?

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Abstract

Forensic science has become a standard feature in criminal investigations and trials. However, it can often be a challenge for experts in courtrooms to communicate scientific evidence clearly to lay audiences through verbal expert witness testimony alone. The Evidence Chamber is an interactive experience engaging public audiences with forensic science through a mock trial. This study explores the effectiveness of using comics to support the understanding of forensic science by non-experts. The results suggest comics were effective at aiding the audiences' comprehension of forensic science evidence and in the future comic-based aids could support juries' comprehension of scientific evidence.

Keywords

Public perception of science and technology

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1 ▪ Introduction

Forensic science has become a standard feature in criminal trials worldwide involving expert witnesses providing opinions based on their knowledge and experience to assist jurors in decision making [Howes, 2015a, 2015b]. Forensic experts must communicate scientific evidence clearly and effectively so jury members or the judiciary can make fully justified decisions.

Poor and ineffective communication by experts during trials can lead to miscarriages of justice [Hackman, 2021]. Due to the gravity of the outcome, it has been argued that communicating forensic science to the jury is perhaps one of the most impactful examples of science communication [Black & Nic Daeid, 2015].

However, over the past decade it has been suggested that the communication of scientific evidence in the courtroom is often ineffective, with increasing commentary that forensic science is at a "critical juncture" in which the communication and comprehension of scientific evidence are being questioned [Science and Technology Select Committee, 2019; O'Brien et al., 2015].

Some potential solutions to the challenge of communicating science in the courtroom have been suggested [Howes, 2015a, 2015b]. However, there is an inherent difficulty with testing potential solutions in the UK and other jurisdictions, as involving jury members in research is restricted. So researchers often call on mock juries and a trial can be difficult to reproduce. This project is one of the first examples of how we might conduct research using innovative digital tools in a simulated courtroom setting [Doran et al., 2021].

In 2019, The Evidence Chamber, a highly interactive science engagement experience, was created by forensic scientists at the Leverhulme Research Centre for Forensic Science at the University of Dundee, Scotland (LRCFS) and a team of digital performance artists at Fast Familiar, a charitable organisation that creates experiences using technology and digital tools. The Evidence Chamber combines entertainment, and public engagement with science with research into the effectiveness of science communication in a fictitious courtroom designed to be as realistic as possible within the constraints of time and technology. The experience uses iPads to guide 12–15 participants (the 'jury') through witness presentations — prompting them to discuss the information as a jury at certain points in the process. An overview of the format is available in Doran et al. [2021]. This format was based on an earlier version of an in-person game, 'The Justice Syndicate' created by Fast Familiar and a discussion of how similar that game is to a real jury and trial setting was written by Barnard and De Meyer [2020].

The Evidence Chamber engages the public through an immersive fictional murder case focused around two types of forensic evidence; gait analysis and DNA analysis. These evidence types are presented to the audience through verbal expert witness testimonies. Participants are also presented with two scientific comics that explain both evidence types, including their limitations. The Evidence Chamber provides an opportunity to test the effectiveness of comics at communicating complex forensic science to lay audiences.

This method of using science comics within the forensic science and justice context is a new area of research, however using comics as a tool for science communication is not [Farinella, 2018; Tatalovic, 2009]. Comics are an increasingly popular form of science education and

communication [Farinella, 2018, p. 2]. As such, comics may be good candidates as a means of presenting forensic science concepts to lay audiences.

This research aims to understand how scientific comics presented in The Evidence Chamber helped participants understand scientific evidence, and how the science comics affected the participants' decision-making. The verbal comments from participants gives us an understanding of how forensic evidence is understood by lay audiences and can be used as part of a wider consultation on improving science communication in the courtroom, as well as contributing to the existing literature on using comics for science communication.

2 ▪ Context and background

2.1 ▪ *The challenges of communicating forensic science to lay audiences*

Forensic evidence is communicated to jury members in UK courts by verbal testimony — a process of examination in chief and cross examination of expert witnesses by the prosecution and defence legal practitioners with occasional questions from the judge in a trial [Bali et al., 2020; Hackman, 2021]. The methods of communication by forensic scientists have fallen under increasing scrutiny since the 2009 National Academy of Sciences report 'Strengthening Forensic Science in the United States' and the House of Lords Science and Technology Committee Report 'Forensic Science and the Criminal Justice System: a Blueprint for Change' in 2019 on the grounds that the science presented is not understandable to lay audiences [National Research Council, 2009; Science and Technology Select Committee, 2019].

Contrary to many scientists, who mostly communicate with other scientists in the same field [Bucchi, 2008], audiences for forensic scientists are primarily non-specialists. The interaction with non-specialists begins during an investigation where forensic scientists work with crime scene managers and crime scene investigators/examiners to identify and recover traces of materials and other items from the scene. Some or all materials may be analysed within a laboratory and the outcome evaluated within the context of the case circumstances and cited as evidence. This forensic evidence may be presented in the courtroom as expert testimony. In England and Wales, to qualify as a juror you must be between the ages of 18 and 76, have registered to vote, and have lived in the United Kingdom for at least five years [UK Parliament, 2019]. In Scotland, anyone over the age of eighteen and on the electoral register can be called for jury service [Citizens Advice Scotland, 2022]. Therefore, typical audiences for forensic scientists are a diverse group of people, with different levels of education and different degrees of understanding and investment in science [Howes, 2015a, 2015b].

There may be a mismatch between the content being communicated and the knowledge of the receivers of the information throughout an investigation and at trial [Hackman, 2021] and the use of specialised scientific terminology has been cited as a barrier to effective communication of scientific evidence [Hackman, 2021]. While there is a body of research exploring how juries interpret forensic evidence [Eldridge, 2019, provides a review], there is a lack of research investigating how much of the science jury members understand.

For some jurors, their time in court could be their first experience of forensic science and they may not have an understanding of specialist language, which according to Halliday and

Martin [1993], is synonymous with understanding the science itself. Jurors cannot directly question scientists, they can only request clarification through the judge [Bali et al., 2020; Howes, 2015a, 2015b]. The rigid formality of the courtroom constrains the potential for discussions whereby deeper understanding of the information can be developed [Bucchi, 2008].

The verbal presentation format is another challenge to effective communication of forensic evidence to juries [Howes, 2015a, 2015b]. Courtroom communication has been described as 'rigid and asymmetrical' due to the number of ways in which witnesses are 'controlled, coerced and manipulated' in hearings and the restrictions placed on witnesses which prevents them from interacting with the courtroom beyond answering questions from the legal representatives [Eades, 2012].

Effective communication by expert witnesses and the comprehension of forensic science by the jury is recognised as a challenge, particularly when there are disputes between experts [O'Brien et al., 2015]. Expert witnesses may, for example, disagree on the reliability of a forensic method employed when a crime is investigated, making it challenging for jurors to determine the extent to which this evidence can be drawn upon to inform a decision on a defendant's guilt or otherwise [O'Brien et al., 2015].

2.2 ▪ *Visual communication in the courtroom*

There are limited studies exploring the effectiveness of visual aids, technology or other presentation methods in the communication of forensic science in the courtroom. Research on juries is heavily controlled which means mock juries and criminal cases are usually used for research purposes [Ross, 2023] and this limits how well we can investigate the effectiveness of communication aids in real trials. In addition, the research that has been done has largely been focused on the decision making of juries rather than their comprehension of scientific evidence and expert witness evidence [Devine et al., 2001]. However, there is a small but growing body of communication research exploring approaches to address current limitations in how forensic evidence is presented in court [Hackman, 2021].

A mock-jury study in the UK found that the verbal presentation of evidence by the expert witness was more effective than written evidence (for example in reports) in increasing jurors' comprehension of mitochondrial DNA evidence and that illustrations did not further increase this comprehension [Summers & Wyler, 2022]. A US study found the use of PowerPoint enhanced the persuasion of mock-juries and their recall of evidence [Park & Feigenson, 2013]. Both studies involved participants who were more educated than a cross section of society.

Animation and computer graphics have been used to present materials in the courtroom but again there is limited research on the effectiveness of this approach. However, what research there is highlights the promise of such techniques. Schofield [2011] described case studies where forensic evidence had been presented to juries in real court cases using video gaming technology, highlighting its potential in aiding comprehension of spatial and temporal evidence. Errickson et al. [2020] found 3D printed models and 3D animations of skulls to aid the understanding of forensic technical language in mock trials more than photographic evidence.

A study involving UK police personnel from England, Wales and Australia highlighted the limitations of presenting evidence visually in courtrooms due to the lack of technology available within the court [Sheppard et al., 2020]. Participants described how paper files and printed albums of photographs are currently used in courtrooms and even where trials of new technology were being run, they involved basic audio-visual technology [Sheppard et al., 2020].

2.3 ▪ *Using science comics as a tool for science communication*

Comics have become an increasingly popular form of communication, with the ability to engage readers of all ages and cultures [Farinella, 2018]. In recent years, there has been a proliferation of studies exploring their utility in communicating science. These studies have explored comics' utility in communicating science to non-expert audiences, as a tool to develop communication skills in researchers [Robin et al., 2021] and as pedagogic tools in schools to teach science [von Reumont & Budke, 2023].

Comics use text and pictures to convey information. Information is divided into panels which can facilitate learning by providing information in easily digestible chunks with a clear chronology [Farinella, 2018]. The panels help to pace the consumption of information and order the information, so explanations of unfamiliar and complex topics can be built up over multiple panels, controlling the pace at which information is introduced to the reader [Kearns & Kearns, 2020].

Another characteristic of comics is the story-telling aspect. Narratives are inherently easier to remember than expository information due to their cause-and-effect structure where an action results in an impact on the narrative [Farinella, 2018]. Narrative can be used to explain scientific phenomena to audiences and enable them to understand the relationship between science and real-life contexts.

Comics are often seen as an easy and playful format [Farinella, 2018], yet due to their features, such as the combination of images and text, they offer useful affordances when presenting complex scientific information. A theory of 'dual coding', where understanding and retention of information is enhanced by use of both visual and textual aspects, describe how comics communicate information [Aleixo & Sumner, 2017].

2.4 ▪ *Previous studies into using comics for science communication*

The effectiveness of science comics in communicating science has been explored in relation to subject matter ranging from chemistry [Weitkamp & Burnet, 2007] to climate change [von Reumont & Budke, 2023], and most commonly health [e.g. Li et al., 2023] and related fields such as neuroscience [Farinella & Mbakile-Mahlanza, 2020]. Comics have been used to communicate information on AIDS, depression and diabetes [McNicol, 2017; Pieper & Homobono, 2000].

While some studies show comics significantly improve understanding and recollection of information such as medical conditions [Farinella, 2018], their impact on information retention is somewhat mixed. In their study exploring the effectiveness of comics in conveying COVID-19 vaccine safety information, Li et al. [2023] found participants did not find comics more interesting or memorable than texts or infographics.

Studies of science comics have attempted to investigate the mechanisms by which comics aid understanding. In their study looking at the effectiveness of comics in communicating chemistry to 7–10-year-olds, Weitkamp and Burnet [2007] noted how the format of the comic engaged the children and they were able to relate their own experiences to a protagonist. Tavares et al. [2023] noted that the range of communicative tools afforded by comics, such as visual metaphor and anthropomorphism, supported understanding of complex cellular and metabolic processes.

The narrative and visual aspects of comics engage the reader at a more personal level [Alemany-Pagès et al., 2022], enabling them to form connections with their own experiences and inform decision-making [Kearns & Kearns, 2020]. While narratives can be a useful means to create a connection between comic reader and the subject matter, Collver and Weitkamp [2018] noted the need to create an engaging visual narrative without compromising the scientific accuracy.

While there is a growing body of literature exploring the effectiveness and affordances of comics in communicating science, to the authors' knowledge, none yet have looked at the use of comics to convey forensic science. Due to the requirements of forensic science communication, such as the need to convey the probabilistic nature of evidence derived from forensic techniques, it is important to investigate the effectiveness of comics in communicating forensic science before they can be considered for use in criminal court cases.

2.5 ▪ *Using science comics as a tool for communicating forensic science to a jury*

As a medium combining visual and narrative aspects, science comics could be well suited to communicate forensic science to jury members in criminal cases. In this study we investigate, for the first time, the effectiveness of comics as a medium to aid the understanding of forensic science evidence using a fictional criminal trial experience.

3 ▪ Methods

3.1 ▪ *Data collection*

The Evidence Chamber is an interactive science engagement experience, where audience members assume the role of a jury member in a fictional murder trial, deciding the guilt or otherwise of an accused based on the evidence presented to them. The performance was developed as an online experience and during the virtual trial, participants viewed video recordings of actors presenting two types of forensic evidence — gait analysis and DNA analysis. In the case of DNA analysis, the evidence was of a technical nature and presented at a fast pace so that the impact of both of these factors could be assessed.

Participants were also provided with the opportunity to read two science comics ('Understanding Forensic Gait Analysis' (Figure 1) and https://discovery.dundee.ac.uk/en/publications/understanding-forensic-gait-analysis-1, [Murray, Vaughan, Nabizadeh, Findlay, Doran et al., 2020] and 'Understanding Forensic DNA Evidence' (Figure 2) and https://discovery.dundee.ac.uk/en/publications/understanding-forensic-dna-analysis

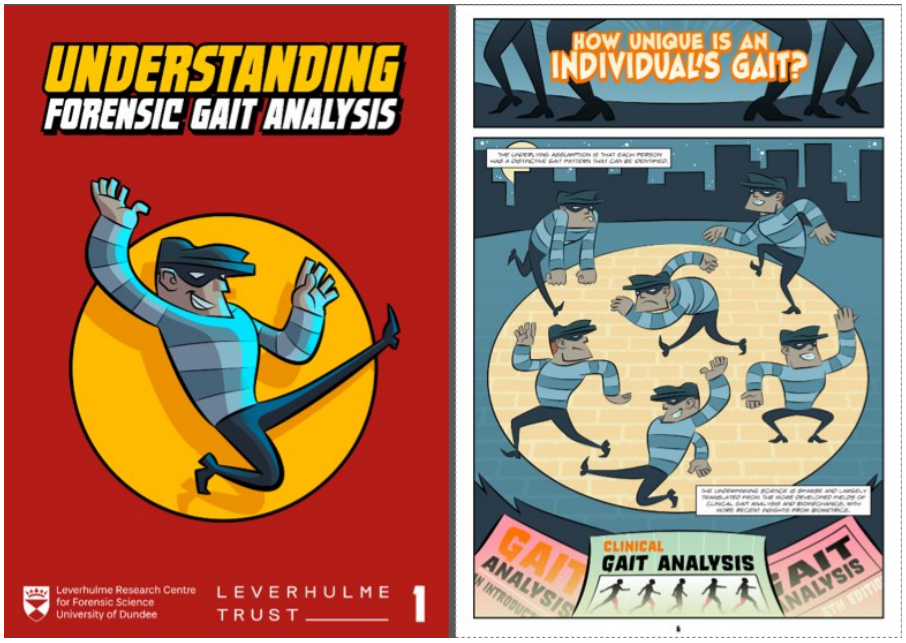

Figure 1. The front cover and one page of the 'Understanding Forensic Gait Analysis' science comic used in The Evidence Chamber.

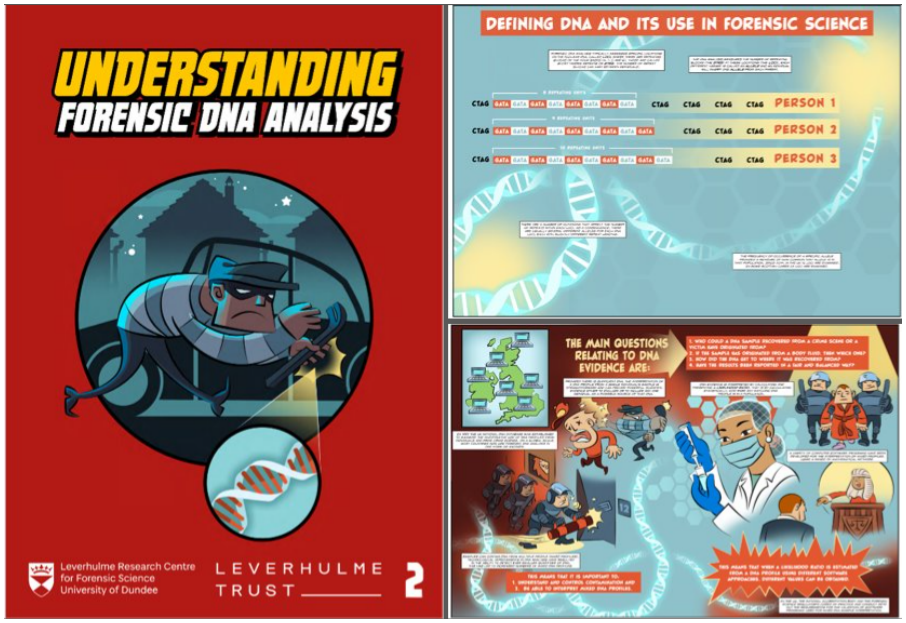

Figure 2. The front cover and two pages of the 'Understanding Forensic DNA Analysis' science comic used in The Evidence Chamber.

[Murray, Vaughan, Nabizadeh, Findlay, Nic Daeid et al., 2020] based on the Royal Society and Royal Society of Edinburgh judicial primers. Judicial primers are documents created with the purpose of assisting the judiciary, explaining scientific concepts, as well as the application and limitations of different forms of forensic science evidence [The Royal Society, 2023; Black & Nic Daeid, 2018].

A total of 106 participants took part in the virtual version of The Evidence Chamber. Participants were recruited through advertisements for The Evidence Chamber experience. These programmed experiences took place online and included two weeks of performances hosted by Fast Familiar, performances at The Encounters Film Festival (Sept 2020), the International Conference on Interactive Digital Storytelling (Nov 2020) and Edinburgh Science Festival 2021. All of these performances were advertised to audiences via electronic methods such as email, social media (Facebook, Twitter and LinkedIn), newsletters and websites via Fast Familiar, the Leverhulme Research Centre for Forensic Science and the host organisation. As these were online events, participants could join from wherever they were in the world, although international audiences were not specifically targeted. Participants were all aged over 18. No rewards or incentives were given for their time. The Evidence Chamber was featured by a number of news outlets, including *The New York Times*, which enhanced its visibility to potential participants. Each virtual performance had up to 12 players. Some in-person Evidence Chamber sessions took place at a university event, but the audio recordings were not of a sufficient quality for transcription, so these sessions do not form part of the results.

Before the performance, individuals were asked to consent to data collection for research purposes. The process for this was approved through an ethics committee at the University of Dundee. The participants remained anonymous throughout and were referred to by a juror number given to them at the start of the mock trial.

Each performance included identical content as all the materials were provided in text and video on tablet computers. An overview of the presentation of information is included in Table 1 and this video: https://www.youtube.com/watch?v=wgzQYnEjFdY provides a description of the format. At specific points in the session, participants were provided with digital comics to aid their understanding of the forensic science evidence. The participants were also asked at intervals throughout the mock trial to anonymously vote on whether they thought the defendant was guilty. These votes were collected through a voting button on screen. After each vote, all jury members were shown the outcome of the vote but they were not told which verdict any individual jury member gave. The audio of the discussions was recorded before being transcribed. The Evidence Chamber was not developed with a preconceived idea of whether the fictitious defendant was guilty or not guilty. So the votes by jury members could not be used to determine whether they were reaching the ‘correct’ decision, purely to explore the impact of the comics on decision making.

A description of the format, data collection methods and why jury members were given a number rather than a name in the virtual performance are described by Doran et al. [2021]. In any performance where a juror refused consent for data collection, the data they input, their verdicts and any audio recordings from that performance, along with the recordings and verdicts of other jurors in the same performance were removed from the analysis. It was necessary to remove all recordings from a performance where an individual jury member did not provide consent as there was no way to differentiate their voice from those of other jurors. Funding for the research was provided by The Leverhulme Trust and Arts Council England.

3.2 ▪ *Data analysis*

Thematic analysis was employed in the data analysis because of its usefulness as a method for analysing and evaluating the perspectives and experiences of different research

Table 1. Ordering of information and voting in The Evidence Chamber.

Vote stage	*Timeline*
	Scene setting (text read out loud by the jury)
	Testimony from the ex-partner of the defendant (Video)
	Telecommunication data from the defendant's phone (Document)
	Crime Scene Examiner report (Document)
	Expert Witness on Gait Analysis (Video)
	Gait Comic (Document)
BLIND VOTE 1	
	Testimony from a colleague of the victim (Video)
	Testimony from a friend of the defendant (Video)
	Testimony from a friend of the defendant (Video)
	Glossary of legal terms (Document)
	Jury discussion 1
BLIND VOTE 2	
	Records from an online chat forum (Jurors read text out loud)
	Expert witness testimony DNA evidence (Video)
	Jury discussion 2
BLIND VOTE 3	
	Testimony from the defendant (Video)
	DNA Comic (Document)
	Jury discussion 3
	Summing up statements from Defence and Prosecution (text read out by the jury members)
	Jury discussion 4
FINAL VOTE	
	Jury discussion (if required)
FINAL VOTE 2 (if required)	
	Jury discussion (if required)
FINAL VOTE 3 (if required)	

participants [Braun & Clarke, 2006; King, 2004]. Thematic analysis has also been proven to be useful for summarising key themes of a large data set whilst still providing a rich and detailed account of the data [King, 2004]. Braun and Clarke's [2006] six-phase process (data familiarisation; coding; searching for themes; reviewing and revising themes; defining and naming themes; reporting) was followed when analysing the data.

A mixture of deductive and inductive coding was used where an initial codebook was generated using previous research into challenges with communicating forensic science evidence [Hackman, 2021; Bali et al., 2020; Howes, 2015a, 2015b; Black & Nic Daeid, 2015] and the characteristics of comics that could make them a good method for science communication [Kearns & Kearns, 2020; Farinella, 2018; Tatalovic, 2009]. After initial coding of the dataset using a preliminary set of codes, additional codes were added to ensure all relevant aspects of the data were captured. Coding was completed using Nvivo (version 1.6.2).

4 · Results and discussion

The Evidence Chamber ran virtually 29 times. Each experience lasted for approximately 90 minutes. In eight of these performances at least one player indicated they didn't wish

Table 2. Age and country of The Evidence Chamber participants.

Age range of participants		*Location of participants (country)*	
18–25	7	Great Britain	85
26–35	26	Australia	4
36–45	32	Germany	1
46–55	24	The Netherlands	3
56–65	10	Brazil	1
66–75	2	Sweden	1
76+	2	USA	1
		South Africa	1
		Ireland	1
		Finland	1
		China	1
		Jersey	1
		Antarctica	1
		Antigua and Barbuda	1
		Singapore	1
		Canada	1

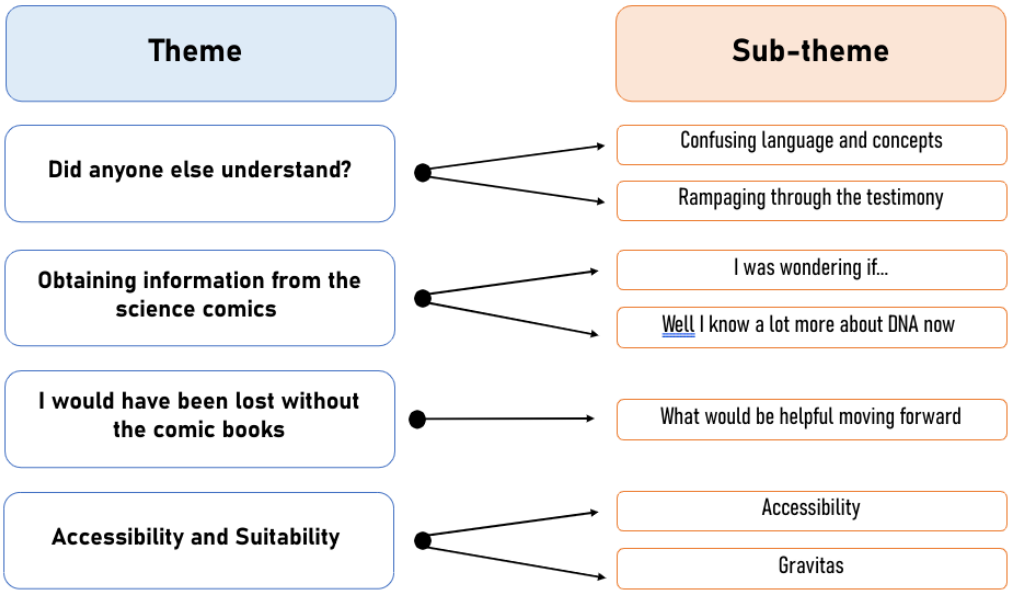

Figure 3. The four themes in blue and sub-themes in orange identified from participant discussions in The Evidence Chamber.

their data to be used for research and the data from these performances was destroyed. In total 106 participants' data was analysed over 21 performances. 77 participants identified themselves as female, 24 as male and 3 as non-binary. An overview of the age range of these participants, their location and described profession is detailed in Tables 2 and 3.

A thematic analysis of The Evidence Chamber data resulted in the development of a series of themes and sub themes illustrated in Figure 3.

Table 3. Profession of The Evidence Chamber participants.

Indicated profession	
Advertising, Marketing, Promotions, Public Relations, and Sales Manager	3
Aircraft Pilot or Flight Engineer	1
Arts, Design, Entertainment, Sports, and Media Occupations	29
Business Owner	4
Chief Executive	2
Computer Specialist, Mathematical Science	1
Construction and Extraction (e.g., Construction Labourer, Electrician)	1
Counsellor, Social Worker, or Other Community and Social Service Specialist	2
Engineering Manager	1
Food and Beverage Serving Worker (e.g., Bartender, Waiter, Waitress)	1
Lawyer, Judge	5
Life Scientist (e.g., Animal, Food, Soil, or Biological Scientist, Zoologist)	2
Not Applicable	6
Opaque	1
Operations Specialties Manager (e.g., IT or HR Manager)	1
Other Agriculture, Maintenance, Repair, and Skilled Crafts Occupation	1
Other Business, Executive, Management, Financial Occupation	2
Other Education, Training, and Library Occupation	5
Other Healthcare Practitioners and Technical Occupation	1
Other Healthcare Support Occupation	2
Other Occupation	3
Other Office and Administrative Support Occupation	1
Other Professional Occupation	5
Other Teacher or Instructor	2
Physical Scientist (e.g., Astronomer, Physicist, Chemist, Hydrologist)	2
Physician	2
Postsecondary Teacher (e.g., College Professor)	7
Primary, Secondary, or Special Education School Teacher	6
Social Scientist and Related Worker	2
Therapist	1
Business Operations or Financial Specialist	1

4.1 ▪ *Theme 1: 'did anyone else understand?'*

This theme captures confusion and misunderstanding participants felt whilst listening to the verbal expert witness scientific evidence, including why it was hard for participants to comprehend. Several participants described how they did not understand the evidence explaining DNA transfer. Jurors are expected to understand the information presented to them and a lack of understanding can mean that the significance of forensic evidence presented can be difficult to apply to the case they are involved with [Hackman, 2021].

> Juror 8c: *"In the DNA analysis what I found confusing was, he [expert witness] gave a number as value judgement, I think for the extremely strong support, and I found that very confusing in the middle of discussion about probability because he put a number to a value judgement that wasn't a probability, so I found that very confusing."*

Within the sub-theme ‘confusing language and concepts’, the use of large quantities and statistics came up frequently in participant discussions as being particularly problematic and confusing:

> Juror 3d: *“I didn’t quite understand what he [DNA expert] was saying. At one point he said something like ‘this was a billion times more likely than this’ but how likely was the first thing? So I mean if it’s a billion times more likely is it still only two percent?”*.

> Juror 1f: *“Some of the quantities they were discussing were so abstract that I couldn’t really get a handle on what that meant in real world terms”*.

The quantities Juror 1f was referring to were numerical expressions of the probability that the DNA profile obtained from samples recovered from the scene was that of the suspect rather than any other individual. These comments arose after jurors had heard the verbal testimony from the DNA expert. This sentiment was common among participants and confirms that they found the evidence difficult to comprehend. Jurors come from a diverse range of backgrounds [Hackman, 2021] and some may not have had any dealings with forensic science before. Participants referenced the numbers (millions and billions) the DNA expert was using and that they could not translate these into ‘real world terms’ suggesting they did not understand the significance of what these quantities meant. Statistics are an important part of communicating forensic science evidence to the court, as they allow experts to assign probabilities to their conclusions. However, many people are not familiar with this type of reasoning or language [Hackman, 2021]. This was evident from the participants’ uncertainty when trying to make sense of what the expert had just said.

Another issue with the expert witness testimonies that arose frequently in juror discussions was a lack of context. Giving audiences context makes comprehension and retention of information easier [Farinella, 2018]. The formal and expository nature of the expert testimony can be hard to engage with, let alone understand and remember.

> Juror 9f: *“Some of the statistics he was giving, I’m not quite sure what he [expert witness] meant”*.

> Juror 3f: “*It was just a running through of statistics and there was really no context to it all, so it left a very confused picture”*.

These extracts highlight that presenting forensic evidence as an isolated scientific fact with little to no context greatly reduces the value of the information being communicated and supports the observations made by Black and Nic Daeid in 2015. The rigid structure of verbal testimonies, woven with complex specialist terminology and statistics, is a barrier to effective communication in the courtroom.

The sub-theme ‘rampaging through the testimony’ also highlighted speed of delivery of expert evidence as a barrier to understanding of the evidence.

> Juror 3f: *"I appreciate the restraints of time, but it was very rushed, he [expert witness] just rampaged through what might have been a statement"*.

The pace of delivery of the expert witness' evidence caused some participants to become frustrated as they tried to note down important pieces of information but were unable to.

> Juror 5c commented *"I found that the DNA expert spoke really fast. I was trying to note down numbers and I got myself in such a muddle"*.

> Juror 3d *"I found the evidence presented by [expert witness] even more confusing because he spoke quite quickly"*.

The participants did not appear to have time to digest the information and were not able to ask the expert any questions. The speed at which the experts were speaking was mentioned as being problematic in five out of the ten performances.

Overall the theme 'did anyone else understand' supports existing research that the current methods of communicating scientific evidence to the lay audiences are problematic [Hackman, 2021; Bali et al., 2020; Howes & Kemp, 2017; Black & Nic Daeid, 2015].

4.2 ▪ *Theme 2: obtaining information from the science comics*

This theme (Figure 3) focuses on what knowledge and information participants gained about forensic science evidence from the science comics provided during the performance. Due to the running order of The Evidence Chamber, it was clear to see what information participants had gained from the DNA science comic.

The theme was split into two sub-themes. The first sub-theme was titled 'I was wondering if…' and captures the questions participants had about what it was possible to achieve using DNA evidence after they had heard the expert witness testimonies. After hearing the DNA expert witness testimony, prior to reading the DNA science comic participants were still left with a lot of unanswered questions. The most frequent question was to do with the possibility of DNA transfer. For example:

> Juror 11g commented *"I don't know whether DNA transfer is possible",*

> Juror 7g asked "*I would ask the question could Mark [suspect's acquaintance] have transferred the [suspect's] DNA?"*.

Jurors cannot question experts in a courtroom [Bali et al., 2020; Howes, 2015a, 2015b] and the nature of expert evidence presentation within the court restricts the potential for deeper understanding of information being presented [Bucchi, 2008]. Participants were left with unanswered questions and in several of the transcribed discussions, jurors were trying to clarify with each other what they had just heard. An example is shown in this interaction between jurors:

> Juror 6f: *"They were both [defendant and defendant's acquaintance] in the same pub at the same time so the question for us is how transferable is DNA, is it a solid link?"*.
>
> Juror 11f: "*Yeah but I don't know whether DNA transfer is possible or not?"*.
>
> Juror 9f: "*Yeah I don't know either"*.

In this fictional case the possibility of DNA transfer, which means transferring an individual's DNA via a vector (such as touching a surface), is an important piece of information the participants should understand. The defendant's DNA is found on a light switch in the victim's house. If there are a number of possible ways for the defendant's DNA to be present on the light switch without the suspect ever entering the victim's house, then the jurors should be made aware of this in a way that is clear to them.

The sub-theme 'Well I know a lot more about DNA now' highlights the participants' reactions after having read the science comics. Participants had learned new information from reading the comics that was helpful to them, evidenced by the contrast between participants' discussions before and after reading the comics. For example, after reading the comics, participants questioning the possibility and likelihood of DNA transfer changed to understanding that it was possible and quite likely under some circumstances.

> Juror 5h commented *"I think the possibility of DNA transfer is more and more likely"*.

The information about DNA transfer in the comic enabled participants to consider different theories about how the DNA from the suspect could have been transferred to the victim's house. After reading the DNA comic, participants started to think about different theories about where and when DNA could have been transferred, specifically referencing the science comics:

> Juror 3b: "*The best bit of the comic for me is showing how DNA can be transferred. The suspect saw Mark Collins [suspect's acquaintance] who worked at the victim's house the day before the victim was killed, so Mark Collins could have transferred the suspect's DNA to the victim's house"*.
>
> Juror 11g: *"Just reading the information [science comic] about DNA, in terms of the transfer from person to person, and then from that person onto the light switch, it looks possible"*.
>
> Juror 4e: *"So from the DNA comic that they put forward, I read that DNA can be transferred from a firm handshake so did Mark Collins [suspect's acquaintance] meet Andrew [suspect] in the pub before he went to the house that night?"*.

> Juror 9d: *"The crime scene report says that the DNA of the defendant was present [in the victim's house] but given everything we've seen in the comics about how secondary contact can pass that across, that doesn't necessarily mean that the defendant himself was present in that location at all"*.

None of these theories came up in discussions prior to reading the comics as participants did not know that DNA transfer was possible as the expert witness did not explain it clearly enough. This adds to existing evidence that verbal testimony alone is not always accessible to lay audiences [Howes, 2015a, 2015b; O'Brien et al., 2015].

Taken together, these two sub-themes indicate that the information participants gained after reading the DNA science comic changed their knowledge and perspectives on what the DNA evidence meant.

4.3 ▪ *Theme 3: 'I would have been lost without the comic books'*

This theme captures the positive experiences participants had when interacting with the science comics. The majority of participants enjoyed reading the comics and found the content helpful:

> Juror 10b commented that: *"I think the comics were really cool and the information was really useful"*

> Juror 9f said that "*I would have been lost without the comic books. I loved the comic books"*.

The visual and narrative properties of comics are important for contextualising abstract processes [Alemany-Pagès et al., 2022]. The science comics in The Evidence Chamber helped to contextualise DNA and gait analysis by providing real world examples. This is something the expert testimony did not do. For example:

> Juror 4b commented that they: *"especially liked the picture in the comic of the gun, showing the transfer of DNA"*.

When comparing the science comics to the verbal expert testimonies, science comics aided participants' comprehension of forensic scientific evidence more than the verbal testimony. The science comics have visual components which were absent in the expert testimony. The combination of imagery with text supports the 'dual coding' theory where understanding of the information is enhanced through the combination of these two approaches [Aleixo & Sumner, 2017]. Instead of only listening to someone explain how DNA may get transferred, the imagery of DNA getting transferred via a handshake or from a phone made the process tangible.

> Juror 10b commented that *"The best part [of the comic] is where they show all the different people who have handled something and then how the DNA gets transferred"*.

The science comics are broken down into digestible chunks that allowed participants to read and absorb the content at their own pace, unlike the rapid verbal expert evidence. This self-paced consumption of information is easier to understand and remember [Kearns & Kearns, 2020; Farinella, 2018].

> Juror 9f suggested that *"If I had read the science comics first, I would have made more sense perhaps of what I was hearing from the expert witnesses"*.

The sub-theme 'What would be helpful moving forward' explores the participants' suggestions of what they thought would be helpful to improve communication between expert witnesses and the jury. The participants suggested tools such as the comics would be useful in a real courtroom:

> Juror 4c: *"I did enjoy how we had those explanations [science comics] at the end explaining what DNA is, explaining all the steps, that's actually quite helpful. I don't know if you have that when you are in the physical courtroom but that would definitely be helpful for people"*.

A second suggestion that came up frequently, was the possibility of having a transcript of the expert witness testimony so participants could refer to it rather than having to rely on their own notes:

> Juror 5c: *"I really wanted to have a transcript afterwards that I could then go back to and refer to after the fact"*.
>
> Juror 4b: *"It was difficult to remember what some of the witnesses said so a transcript would be good"*.

Having a transcript would combat the issue of the expert witnesses talking too quickly, but it may still be confusing. Reports or written statements often contain specialist language that is not easy for lay audiences to understand [Bali et al., 2020; Hackman, 2021; Howes, 2015a, 2015b]. Participants also discussed that having a small summary in simplified language could also be a useful resource.

4.4 ▪ *Theme 4: accessibility and suitability*

The sub-theme accessibility explored the interactions participants had with the science comics. Most participants discussed having positive interactions with the science comics. However there were participants who discussed having a negative experience due to accessibility issues. It is important to record these negative experiences as it can help improve the comics. Most issues arose from text format and placement.

> Juror 1b: *"I couldn't read it because it was all in capitals which is not accessible but the context is good"*.
>
> Juror 10b: *"The information could be presented in a much more reader digestible way and much more accessible way, I'm thinking people with visual impairment or struggle to read things in certain ways"*.

The participants accessed the comics on tablets, laptops and computers with relatively small screens. Having printed comics may make text easier to read and potentially combat some accessibility issues.

The sub-theme 'gravitas' explored the idea that using comics in a real jury trial would not match the seriousness that is required of the situation. Some participants felt that comics were not suited to play a role in a criminal trial:

> Juror 10b: *"They [comics] felt a little bit patronising but it didn't fit with the gravitas of what was going on"*.
>
> Juror 1i: *"Why are you using animated images to explain DNA, I just don't understand, I presume that would never happen in a real jury situation"*.

Comics can be seen as a playful format [Farinella, 2018] and have used fun and wacky characters to engage a diverse range of readers in different scientific topics [Tatalovic, 2009], however, they have also been used to convey information about serious scientific subjects, especially in the healthcare arena [Alemany-Pagès et al., 2022; Kearns & Kearns, 2020].

An overview of the voting pattern is provided in Figure 4. Additional 'final votes' are only taken if the jury fails to reach a verdict in the first 'final vote'. The verdicts (votes) give an indication of how participants are feeling about guilt of the accused. The analysis of the discussion helps us better understanding of how the comics have been used to understand the expert witness testimony.

5 ▪ Conclusions

Results from this study have provided evidence that innovative mediums, such as science comics, may be used as a vehicle to present information about complex forensic science processes in a clear and understandable way. Participants in The Evidence Chamber used the science comics to enhance their understanding and increase their knowledge of the forensic evidence presented by the expert witnesses. The information about DNA transfer participants gained from the comics altered their opinions on whether they thought the defendant could have committed the crime. The illustrations in the comics enhanced readers' comprehension and the contextualisation of forensic processes, such as DNA transfer, and made abstract concepts tangible.

The results also show that verbal expert witness evidence was confusing for lay audiences and was sometimes ineffective at communicating important scientific information, mainly

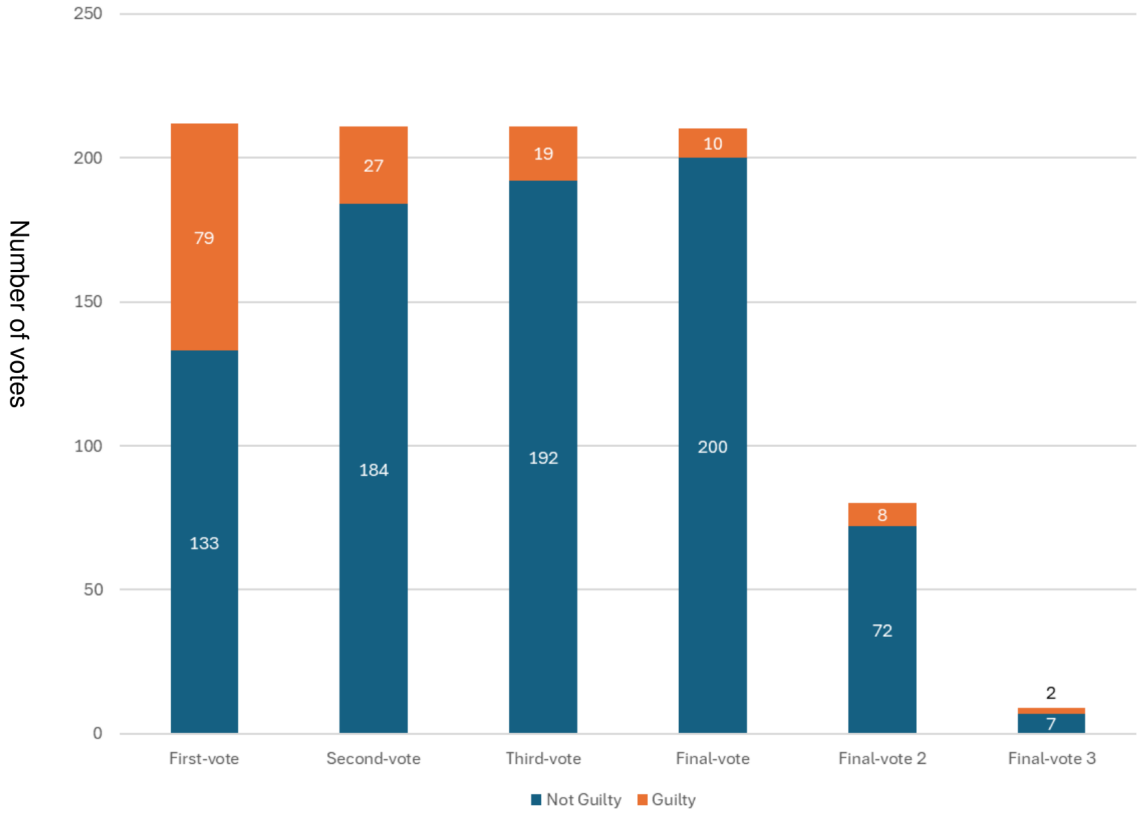

Figure 4. Collated verdicts at different points in the performance. Each vote represents one participant.

due to the complex language used, the lack of context, and the speed experts spoke. The forensic evidence presented in The Evidence Chamber was based on how such scientific concepts would be discussed in real casework and the results support the current literature stating communication of forensic science evidence to lay audiences needs to be improved. The participants indicated written summaries or transcripts would be helpful. However, in a court expert witnesses are answering questions from the defence and prosecution, making it difficult for transcripts to be created to aid a jury. Identifying issues such as these will inform a robust understanding of the challenges with communicating forensic science to lay audiences, and explore innovative solutions, such as science comics, for effective and accurate science communication in this context.

This study is an initial exploration of using a creative method to investigate if science comics are useful aids for aiding the understanding of forensic science. While many participants were attending non-science events, a limitation of this study is that some participants were attending a science-focused event and so may be more accepting of science comics than the general population. Further research would be needed to understand the benefits, effectiveness and also the challenges of using science comics with a real jury in a trial scenario. However, this study provides evidence that the science comics, or an alternative approach that also uses text and images, may enhance the understanding of forensic evidence in real courtrooms.

Conflict of interest statement
Some of the co-authors in the research are lead artists at charity Fast Familiar and offer similar interactive event services commercially.

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