

A mixed-methods analysis of judges' views and decision-making surrounding scientific evidence in criminal sentencing

Mia A. Thomaidou

Rutgers, The State University of New Jersey

Colleen M. Berryessa

`colleen.berryessa@rutgers.edu`

Rutgers, The State University of New Jersey

Sandy S. Xie

Rutgers, The State University of New Jersey

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Abstract

Background: In contemporary criminal justice systems, the integration of bio-behavioral science evidence into legal proceedings poses complex challenges as well as opportunities. As psychiatric and mental health evidence may often not be accompanied by expert testimony, judges in criminal courts may be tasked with alone interpreting and incorporating this evidence into their decision-making processes.

Methods: This study investigates how judges—shaped by their views, beliefs, and personal characteristics—approach decision-making processes during sentencing in light of scientific explanations of behavior, as well as how their views on sentencing may be impacted by mental disorder diagnoses. We utilized a mixed-methods approach, including Natural Language Processing techniques (sentiment analysis and structural topic modeling) as well as qualitative analysis, to analyze data from semi-structured interviews with 34 judges from state criminal courts in the U.S.

Results: Results revealed varying degrees of belief in scientific determinism among judges, with corresponding sentiment analysis indicating differences in emotional tone across gender, age, geographical region, and professional background. Structural Topic Modeling identified key themes, including determinism, responsibility, treatment needs, and philosophical considerations surrounding punishment. Qualitative analysis enriched these results by unraveling the philosophical and legal considerations that judges grapple with when considering scientific explanations for defendants' behavior.

Conclusions: Findings underscore the nuanced interplay between scientific understandings of behavior, personal beliefs, and judicial decision-making. This study offers valuable insights into the potential complexities of sentencing considerations involving scientific evidence and underscores the need for standardizing how scientific evidence is presented in courts and investing in science education for judges.

Introduction

Over the past several decades, scientific evidence concerning individuals' biology and behavior has been increasingly presented in criminal courts (1, 2). While forensic science has long established its place in criminal justice decision-making, psychiatric and psychological evidence presented as scientific explanations of behavior are a more recent addition to the criminal justice process. Importantly, in contrast to forensic evidence that is consistently presented and explained by expert witnesses (3, 4), evidence regarding mental disorders or adverse life experiences may be often presented in a less formal manner and sometimes without accompanying expert explanations (5). As a result, judges are often required to rely on their own understandings and interpretations of such evidence and information, which may leave sentencing processes vulnerable to misconstructions of scientific evidence and inconsistent interpretations based on judges' views and prior knowledge (6). As courts are increasingly asked to consider scientific explanations for behavior, it is imperative to better understand what knowledge judges rely on and what processes they follow in their decision-making when faced with such evidence. The present study relies on a mixed-methods analysis of interviews with judges in United States (U.S.) criminal state courts, aiming to extricate decision-making processes in light of scientific explanations of behavior.

Bio-behavioral science to date has offered valuable insights into the complex interplay between the biological and environmental factors that shape people's personalities and behaviors; this type of knowledge has the potential to inform criminal justice decision-making, especially in the sentencing stage, in two main ways. First, although sometimes limited in its potential applications, scientific evidence can inform practical aspects relating to sentencing, such as an individual's legal responsibility (for instance, whether a person has knowingly or intentionally engaged in a criminal act), their dangerousness, competency, and their amenability to treatment (7–9). Second, bio-behavioral evidence has been thought to potentially augment the understanding of an individual's moral responsibility—particularly by illuminating the biological dispositions and environmental influences that may have shaped their behavior (10–12). Judges may thus consider the practical and/or philosophical relevance and informativeness of bio-behavioral science evidence during sentencing determinations.

In the U.S., scientific explanations for behavior, including mental health evidence, are acknowledged in procedural law; yet they are frequently applied only to the most severe cases involving cognitive or behavioral impairments (10, 12). Most states have

legal provisions for mental health pleas, allowing defendants to be found not guilty by reason of insanity (NGRI) or guilty but mentally ill (GBMI) (13). These laws recognize that individuals may commit crimes due to severe mental illness, either absolving them of criminal responsibility (NGRI) or acknowledging their mental illness as a driver of behavior while still holding them accountable (GBMI) (13). At the same time, the potential mitigating role of mental health conditions is reflected in the Federal Sentencing Guidelines, but the "unusual degree" requirement (14) mandates that only the most extreme cases of disorders that have a profound and direct impact may justify a departure from the sentencing guidelines. No steadfast rules or guidelines exist to define if and how the more common, less serious types of mental health conditions should impact sentencing.

Criminal cases that do not rise to the level of a mental health plea may involve an array of different congenital and acquired mental disorders. Evidence presented in these cases may include medical and psychiatric records, psychological evaluations, or pre-sentence investigations (PSIs) that partly outline factors such as experiential and environmental influences on individuals' behavior and any history of traumatic or substance use disorders (15). While clinical experts may present and explain complex biological evidence, such as genetic tests or brain scans, in most cases psychological evidence and PSIs are entered into evidence by attorneys or court staff, and judges are tasked with evaluating their significance and relevance (16). For instance, PSIs are typically conducted by court staff with limited clinical expertise (17). Consequently, judges are commonly themselves responsible for evaluating the quality of evidence and assessing the relevance of factors, such as physical or psychological trauma, substance use disorders, and other influences on the particular behavior in question (16–18).

Understanding how scientific evidence, mental disorder diagnoses, or any other explanations for behavior put forward during criminal proceedings affect sentencing outcomes is an ongoing challenge. Research suggests that, in practice, evidence of mental health disorders can function as mitigating, aggravating, or have little effect on sentencing considerations, generally yielding inconsistent effects on sentencing (19–21). One explanation for this varying influence of scientific evidence on sentencing determinations is that some mental health problems may be considered more treatable than others, prompting judges to opt for more rehabilitative and less punitive sentences (8, 22, 23). At the same time, certain mental disorders tend to be perceived as resulting in impulsive or unpredictable behavior, and, thus, may be more likely to be associated with long carceral sentences aimed at incapacitation to prevent the risk of future harm (24, 25).

Another potential explanation for widespread inconsistency in the influence of scientific explanations of behavior on sentencing decisions may be the ways in which judges' own moral and sociopolitical views, or attitudes towards science, affect their interpretations of scientific evidence. For example, scientific determinism—an idea rooted in physical causality and positing that behavior is determined by prior biological and environmental causes—leaves little room for a person to judge another's human actions as though they are the result of free will and, thus, may generally result in reduced attributions of moral responsibility (26).

Indeed, the degree to which decision-makers assign personal responsibility to criminal actors may be critically influenced by their beliefs in determinism as opposed to free will (26, 27). As shown in prior experimental work (26, 28, 29), beliefs that individuals do not possess complete control over their actions may consequently result in lower attributions of moral responsibility and corresponding reductions in punitiveness. Judges that hold a deterministic view of human behavior may be more likely to opt for less punitive sentencing approaches, while beliefs in the idea that humans are free to determine their actions and lives more broadly (which is may sometimes be intertwined with conservative sociopolitical stances and with religiosity) may be more supportive of retribution as a way to restore justice (26, 30). Other characteristics, such as prior education, the extent of scientific training, and personal experiences with mental disorders, may also influence the cognitive filters through which decision-makers process scientific information and punishment decisions (31–35).

Gaining insight into judges' decision-making process and the factors influencing sentencing determinations in cases involving scientific explanations of behavior is crucial for understanding the interplay between law and science. Interview data are particularly informative for answering these questions because it allows for a direct exploration of judges' thought processes, experiences, and perceptions, which are often nuanced and complex (36). By capturing judges' own words and reflections, researchers can gain a deeper and more accurate understanding of the underlying considerations and reasoning patterns they utilize in making decisions during sentencing. Combining Natural Language Processing (NLP) with traditional qualitative analytical methods enhances this approach (37). NLP can efficiently process and analyze large volumes of textual data by

identifying patterns, sentiments, and group differences in expressed attitudes that might not be immediately apparent (38, 39). This computational technique can reveal subtle trends across multiple interviews, while traditional qualitative methods, such as thematic analysis, can additionally provide a detailed, context-rich interpretation of themes existent within the entire corpus of data (40). Together, these methodologies offer a robust framework for comprehensively understanding the factors that influence judicial views and their potential effects on decision-making processes in scientifically complex cases. While mixed qualitative-NLP approaches have recently begun to demonstrate their value in methodological studies (37, 41) and medical research (42, 43), the present study is the first to our knowledge to utilize this mixed methodology in research at the nexus of the fields of psychology, criminal justice, and law for the analysis of interview data.

The current study delves into the process of judicial decision-making, particularly focusing on how judges navigate the complexities of legal decision-making and sentencing in light of scientific explanations of behavior. This work develops a model based on interview data that shows how scientific evidence, considered by judges through their own cognitive filters, influences their perceptions of responsibility, sentencing considerations, and overall decision-making practices. Through in-depth analysis of interview data, the research seeks to elucidate two key, interrelated questions:

1) How do scientific explanations of behavior influence how judges assess notions of responsibility attributed to defendants in relation to sentencing processes?

2) Which potential cognitive biases, heuristics, or scientific misconceptions may impact judges' understanding and interpretation of scientific evidence related to behavior or mental health in sentencing processes?

By addressing these key research questions, this study aims to provide valuable insights into the intersection of bio-behavioral scientific evidence, judicial decision-making, and the administration of justice, particularly at the criminal sentencing stage. Furthermore, by employing a quantitative-qualitative approach, the research seeks to offer nuanced perspectives that complement existing research on judicial decision-making (6, 33, 44, 45). Ultimately, the findings of this study hold the potential to inform policy, practice, and future research initiatives aimed at enhancing the fairness and effectiveness of sentencing processes within the criminal justice system.

Methods

3.1. Recruitment and sample

Contact details (email addresses) for U.S. judges were obtained from the judicial database *American Bench*. The sample inclusion criterion was being a current sitting judge in a U.S. state court who hears criminal matters. Based on a target sample size of 40 judges that is considered sufficient for theoretical saturation in qualitative analyses (46), a sample frame of 880 judges was emailed recruitment letters based on an expected response rate of approximately 5% observed in prior judge studies (44, 47).

Data were obtained from a final sample of 34 judges who currently are or have presided over criminal cases across 16 states. All participants received the information sheet and informed consent form via email prior to the interview. Before the start of the interview, all judges provided verbal consent for participation. All but three judges consented for the interview calls to be recorded and detailed notes and quotes were taken for those interviews. The authors' Institutional Review Board (IRB) approved the study.

3.2. Interview protocol

Data were obtained through semi-structured interviews. Interview durations ranged from 56 to 98 minutes, with an average interview length of just under 74 minutes. Thirty interviews were conducted using video conference (Zoom) and one interview was conducted over the phone due to technical difficulties. For three participants who did not consent to be recorded, extensive interview notes and quotes were documented by the interviewer, to ensure that detailed information could be included in the qualitative analysis.

The first part of the interview comprised a survey and quantitative questions regarding fictional criminal cases, and these data and their materials are reported in a separate article (see Thomaidou & Berryessa, 2024). The remaining part of the interview protocol, which is the focus of the present study, contained semi-structured interview questions. The interview guide was formulated prior to the interviews and iterated through internal testing with the research team to eliminate leading questions and reduce ambiguities. The central topics of the interviews encompassed three areas: 1) sentencing in cases involving mental health evidence; 2) judges' bio-behavioral science education; and 3) their understandings of bio-behavioral determinism and freedom of will. The guide was finalized to include both closed- and open-ended questions that resulted in a logically flowing and clear dialogue.

Closed-ended questions included, for example, questions about judges' education or binary questions on factors considered when assessing mental health evidence. Demographic measures were collected for descriptive purposes and used as metadata in our NLP analysis. Because the main focus of the present study was to examine how scientific understandings of behavior and views regarding defendants influence judgments, participants were asked to report their sociopolitical leanings (coded as liberal, middle, or conservative) and religiosity (coded as yes, a little, or no belief in any higher power), the importance they place on goals of sentencing (rehabilitation, restoration, deterrence, retribution, incapacitation), and variables such as the focus of their prior education and work as well as the sources and level of their scientific knowledge.

Moreover, a validated questionnaire, the Free Will and Determinism Plus scale (FAD-Plus) was also used to assess the degree of belief in determinism and corresponding disbelief in free will (48). This scale is designed to capture the extent to which individuals perceive human actions as being governed by personal agency versus external forces or predetermined outcomes. The scale includes 27 Likert-type items on a scale from 1 (strongly disagree) to 5 (strongly agree) across four subscales (free will, scientific determinism, fatalistic determinism, unpredictability). For the purposes of this study, 10 items from the scale directly relevant to free will and scientific determinism were administered to judges (ranked on a scale of 1 to 5), with total scores ranging from 10 to 50.

Open-ended interview questions focused on judges' understandings of mental health and behavioral control, for example asking, "In what ways, and how strongly, do you think a person's inherited traits and genes influence their behavior, character attributes, or personality?" Remaining demographic questions, including those that could be considered as leading or priming participants to give certain types of responses such as questions about judges' prior work, education, and sociopolitical or religious beliefs, were asked at the end of the interview as close-ended questions. The full interview guide and measures used are found in the supplemental material [see Additional file 1].

3.3. Analytical plan

This study utilized a mixed-methods, analytical approach. Data were analyzed both quantitatively (in Python 3.1) and qualitatively (in Dedoose 9.2).

3.3.1. Quantitative analysis and NLP

First, quantitative data were summarized using descriptive statistics. Total scores on the adapted FAD-Plus were calculated; the free will subscale items were reversed so that higher total scores on the questionnaire indicated higher beliefs in determinism and disbelief of free will (48). Belief in determinism and corresponding disbelief in free will were then classified into low, moderate, and high belief in determinism by calculating percentile scores. The minimum total score was 15, and the classification was as follows: scores falling below the 33rd percentile (cutoff: 20) were considered low, those between the 33rd and 67th percentiles (ranging from 21 to 31) were considered moderate, and scores above the 67th percentile (ranging from 32 to 41) were classified as high.

NLP techniques were then used to extract insights from the interview transcripts. This analytical approach involves employing computational methods to parse, classify, and derive meaningful insights from the language captured in the interview transcripts (38). First, we conducted sentiment analysis, a subfield of NLP that involves identifying and categorizing the emotional tone expressed in text, which helps discern attitudes, opinions, and feelings conveyed within the language (38). In our sentiment analysis, polarity scores were computed, representing the emotional tone of the text, ranging from -1 (negative

sentiment) to 1 (positive sentiment), with 0 indicating neutrality. Polarity scores represent the degree of positivity, negativity, or neutrality of sentiments detected in the text, offering quantifiable measures for analyzing emotional nuances in words or phrases used by the interviewees. The average polarity scores were compared across six grouping variables (Gender, Age, Geographical region, Personal political leaning, Prior work, and Belief in determinism). This facilitated an examination of sentiment variation within the dataset. Sentiments detected in the transcripts are related to an overall positive or negative stance throughout an interview or, for example, expressing optimism or approval of the concepts and topics discussed within each interview. The qualitative analysis section below elucidates particular ideas that judges discussed in a positive or negative light.

We then used a Structural Topic Modeling (STM) approach (39) to generate topic models while incorporating metadata from the same six variables of interest (Gender, Age, Geographical region, Personal political leaning, Prior work, and Belief in determinism). Topic models are statistical models designed to uncover latent topics within a corpus of text documents; these models are particularly valuable in discovering thematic structures in unstructured text data. Unlike traditional unsupervised topic modeling approaches, which treat documents uniformly, STM allows for the incorporation of covariate information, enhancing the interpretability and granularity of the topic modeling process (39). STM can extend traditional Latent Dirichlet Allocation (LDA) models and capture nuanced relationships between topics and metadata variables. In our study, we adapted an LDA model, enhanced by STM's ability to incorporate covariates, to gain deeper insights into between-groups differences in the thematic content of our interview transcripts. The transcripts were tokenized and cleaned to remove non-alphabetic characters, expand contractions, remove punctuation, convert all text to lowercase, and remove stop words. The adapted LDA model finds topics in a collection of documents based on word frequency patterns (39). Here, LDA was trained on a merged matrix of documents and meta-data. The LDA model detected top words associated with different topics, calculated topic weights for each document, and grouped these topic weights based on metadata to make observable the topic distributions along the variables of interest.

We followed an iterative process to determine parameters, such as the optimal number of topics for our analysis and labeling topics into major themes. Words that were common among many topics were ignored as they effectively cancel each other out; for instance, "behavior" and "bad" were common words that the model included in most topics and thus did not play a role in the topic label. Thus, this process involves a qualitative analysis component that is common practice in labeling LDA-generated topics; indeed, language models cannot satisfactorily derive understandable labels for complex topics involving nuanced concepts in the way human language processing can, and, as a result, it becomes hard to automatically derive a meaningful label for a topic (49, 50).

3.3.2. Qualitative analysis

The interviews were first transcribed by Zoom and then checked and corrected by the interviewer. We used Dedoose software and implemented both deductive and inductive coding strategies (51) to identify themes related to judges' scientific understandings of behavior, decision-making, and resulting punishment attitudes. First, deductive coding was used to create a list of open codes based on the interview protocol and the topics identified through the NLP results. These open codes captured the theoretical foundation for understanding judges' decision-making processes when considering scientific explanations of behavior. Next, these open codes were inductively refined and organized into coding categories to achieve theoretical saturation of the data (51, 52). This inductive coding step classified judges' responses into more specific parent (depth 0) codes that emerged from the interview data.

Following this, the parent codes that were identified were further divided into contrasting attitudes, i.e., responses indicating agreement/positive stances versus disagreement/negative stances within the topic captured by each parent code. This second inductive step aimed to identify contrasting opinions regarding the topics and attitudes discussed and resulted in sub-category (depth 1) codes of the parent (depth 0) codes. Finally, during the final step of inductive analysis, eleven identified parent codes (which included several sub-codes each), were theoretically organized into coding categories (40) that concerned judicial decision-making in light of scientific knowledge and mental health evidence. In order to ensure the robustness and reliability of the coding process, a random subset comprising 20% of the assigned codes underwent review by an independent coder to gauge the level of agreement and inter-rater reliability between the primary coder and the independent reviewer. The agreement

between coders was 96.8% and where disagreements were found (3.2% of reviewed codes), these were resolved by discussions among the coders.

Results

4.1. Demographic characteristics

Full demographics of the research sample are found in Table 1. All hold an undergraduate degree across several disciplines. Relevant to understandings of mental illness, only two judges majored in biology or biomedical science and four majored in psychology (see **Fig. 1**). All attended law school and hold a Juris Doctorate, and two judges had a further postgraduate diploma (see **Fig. 1**). Participants reported receiving prior scientific education from a variety of sources and most commonly through their experience presiding over cases (82% of judges listed this as the major source of their science knowledge). Only four judges reported having no direct experience with mental disorders in their personal lives or within their families. On average, judges reported that 12% of their scientific knowledge is acquired through popular media ($SD = 11.1$). They reported having attended on average 20 different educational seminars, trainings, or other relevant professional learning sessions on bio-behavioral science topics throughout their careers, although there was a large variation in this ($SD = 23.8$). All participants reported having attended at least one professional training or seminar about bio-behavioral science or mental disorders.

Judges in our sample were based in 16 different states. We categorized these states as “blue,” “purple,” or “red” based on the consistent majority vote in the last six presidential elections from (53). In terms of their own self-reported sociopolitical leanings, eight liberal judges were located in “blue” states, four were in “purple” states, and three were in “red” states. Moderate judges were spread more equally, with four in “blue”, three in “purple”, and two in “red” states. No judges that reported themselves as conservative were located in “blue” states, only one was in a “purple” state, and nine were in “red” states.

The average total score on the FAD-Plus questionnaire was 28 ($SD = 6$). Liberal judges had the highest determinism scores, while no conservative judges scored high on determinism. Most judges that scored low on determinism belief reported a conservative political leaning and being religious.

[INSERT FIGURE 1 HERE]

Figure 1. Summary of characteristics related to judges’ state and region, educational background, as well as prior and current work.

Table 1
Summary statistics, judge demographics, and determinism scores.

Variable	Category	Count (total = 34)	Percent (%)	Determinism Score (10–50)
Gender	Female	10	29%	25.7
	Male	24	71%	29.5
Age	40–49	9	26%	29.1
	50–59	10	29%	18.4
	60–69	13	38%	28.7
	70–80	2	6%	23.0
Years-Judge-Career	0–5	8	24%	27.4
	5–9	9	26%	29.0
	10–19	11	32%	28.6
	20–29	5	15%	27.0
	30–40	1	3%	35.0
Region	West	12	35%	29.4
	Mid-west	10	29%	30.3
	South	12	35%	25.8
Political Leaning	Liberal	15	44%	30.7
	Middle	9	26%	30.2
	Conservative	10	29%	23.2
Religious	No	7	21%	30.4
	Somewhat	10	29%	30.0
	Yes	17	50%	26.6
Master's Degree	No	32	94%	28.0
	Yes	2	6%	34.0
Specialty Court	No	22	65%	27.9
	Yes	12	35%	29.2
Science Knowledge Source *	Professional Training	22	65%	26.6
	College	4	12%	33.5
	Conferences	4	12%	32.0
	Personal Life	2	6%	29.0
	Reading	2	6%	30.0
Self-Report Science Knowledge Level [±]	Average	9	26%	26.8
	Above average	24	71%	28.8
	Excellent	1	3%	32.0

Variable	Category	Count (total = 34)	Percent (%)	Determinism Score (10–50)
NOTE: Determinism total scores range from 10 (low belief in determinism and high belief in free will) to 50 (high belief in determinism and low belief in free will). * Main source of knowledge other than experience within the court. ± Self-Reported on scale ranging: 1 (Poor), to 5 (Excellent), in reference to the average person.				

4.2. Natural Language Processing results

Sentiment analysis of the interview transcripts detected 34 individual occurrences (instances) of sentiments expressed through individual words or lengthier phrases, with each instance representing distinct expressions of positive, negative, or neutral sentiments captured by the model. The analysis found that, among the sentiments identified, positive, negative, and neutral sentiments reflected the predominant emotional tone of the interviews. Nineteen instances were classified as positive and indicated that expressions of optimism, contentment, or more generally positivity were most dominant in the judges' discussions of the interview topics. On the other hand, 14 instances were categorized as negative, suggesting expressions of dissatisfaction, skepticism, concern, or negativity in discussions of the interview topics. Only one instance was classified as neutral.

When comparing sentiments between the six grouping variables (gender, age, geographical region, personal political leaning, prior work, and belief in determinism) by computing polarity scores (see **Fig. 2**), the analysis identified more positive sentiments in the responses of female judges (higher polarity scores) compared to male judges. In other words, female judges tended to convey more positive emotions or favorable attitudes in their language and use more positive or optimistic words and phrases when discussing the interview topics. Younger judges were also found to express more positive sentiments, compared to older judges. In terms of geographical regions, judges located in Western U.S. states exhibited the most positive sentiments. State politics, self-reported political leanings, and degree of religiosity showed mixed results (**Fig. 2**). Judges who primarily worked as criminal defense lawyers or public defenders exhibited more positive attitudes than those who had mostly worked on the prosecution side before becoming a judge. Judges who have roles in specialty courts and those with lower beliefs in determinism also had marginally lower polarity scores.

Structural topic models, with a target of eight topics, yielded the most informative and coherent thematic structures across all six grouping variables (gender, age, geographical region, personal political leaning, prior work, and belief in determinism). In **Fig. 3**, each bar in the plot represents the average importance (weight) of a topic for a specific metadata category. The major topics identified by the structural topic models included: 1) determinism and the role of luck; 2) responsibility; 3) victims; 4) unpredictability in behavior; 5) treatment needs and treatability; 6) life experiences and mental health; 7) nature versus nurture; 8) trauma and other disorder diagnoses; 9) science topics in biology and psychology; 10) relevant laws and sentencing guidelines; 11) needs of the community, 12) dangerousness, and 13) more philosophical aspects around criminal justice and punishment. For example, one frequently detected topic was related to determinism and luck (category one), as indicated by the detection of a list of co-occurring words such as "behavior, decision, control, luck, organic, choice, sometimes, healthy, deal, bad." Another common topic was labeled as a discussion around dangerousness (category 12) and included word patterns such as "behavior, mental, healthy, dangerous, bad, prison, risk, society, system, also." These themes align with the areas of focus of the semi-structured interviews.

For each grouping variable, topics were similar, but not identical. Between-group comparisons revealed several differences in the topics of focus between judges with different characteristics (see **Fig. 3**). For example, the treatment needs of defendants and treatability of disorders had a higher average topic weight among female compared to male judges, as well as among younger compared to older participants, and among judges who previously worked as criminal defense lawyers. We also observed that self-reported conservative judges and those located in Southern states focused mostly on the dangerousness of defendants with mental disorders, as did judges who previously worked as civil lawyers or as prosecutors. Discussion of determinism and the role of luck was found mostly in the interviews of judges who had high belief in determinism, judges who previously worked in criminal defense roles, liberal judges, judges in the Midwest, and those aged 50–59.

[INSERT FIGURE 2 HERE]

Figure 2. Visualization of the sentiment analysis, displaying average polarity scores between the categories of each of nine judge characteristics.

[INSERT FIGURE 3 HERE]

Figure 3. Visualization of the Structural Topic Modeling results, displaying average topic weights between the categories of each of six judge characteristics.

4.3. Qualitative results – Influences on decision-making

Qualitative analysis of the interview transcripts illuminated judges’ views and relevant considerations when faced with scientific explanations of defendants’ behavior during sentencing. NLP results helped identify open codes and inductive coding resulted in 11 parent codes (depth 0) and their sub-codes (depth 1). Table 2 shows a list of the count of total occurrences of each of the qualitative codes assigned to transcript excerpts. The 11 identified codes and their sub-codes were organized into three primary categories that spoke to the factors that influence judges’ views and subsequent decisions when considering scientific explanations for behavior: (1) *Perspectives on behavioral determinants and moral responsibility impact decision-making*; (2) *Attitudes towards scientific evidence impact decision-making*; and (3) *Biases and scientific misconceptions impact decision-making*.

The first category includes five sub-themes (‘Choice and control’, ‘Luck’, ‘Free will and determinism’, ‘Blame and responsibility’, ‘Empathy’) that marked discussions of how sentencing decision-making is influenced by ideas regarding the determinants of behavioral outcomes and corresponding degree of moral responsibility. The second category comprised three themes relevant to judges’ decision-making in light of scientific explanations of behavior (‘Attitude towards science’, ‘Disorder relevance’, and ‘Excuses or expressing skepticism about psychiatric diagnoses’). The final category includes three themes relating to ‘Biases and scientific misconceptions’ about evidence related to behavior and mental health and relevant conclusions drawn regarding ‘Dangerousness and reoffending’, and ‘Treatability and treatment willingness’. The findings achieved theoretical saturation within the data and, for clarity, minor grammatical and punctuation corrections were made to the interview excerpts presented below.

Table 2
List of total occurrences of each of the qualitative codes assigned to transcript excerpts.

<i>Codes Depth 0</i>	<i>Codes Depth 1</i>	<i>Count</i>
<i>Free will and determinism</i>	Belief in determinism/disbelief in free will	20
	Belief in free will/disbelief in determinism	25
<i>Luck</i>	Belief in luck	5
	No belief in luck	10
	Belief luck plays a small role	23
<i>Blame and responsibility</i>	Healthy is as responsible as disorder	22
	Healthy is more responsible than disorder	40
	Deterministic version of healthy = disorder	12
<i>Choice and control</i>	Disorder diminishes choice	16
	Disorder does not diminish choice	9
	Disorder linked to impulsivity/lack of control	51
	Disorder more dangerous than healthy	55
	Worry about dangerousness	17
<i>Attitude towards science</i>	Trusts science	6
	Science is unreliable/worry about junk science	20
	Skeptical or unsure about science	60
<i>Disorder relevance</i>	Relevance inherent	25
	Relevance skepticism	38
<i>Excuses/skepticism about diagnoses</i>		17
<i>Biases and scientific misconceptions</i>		110
<i>Dangerousness and reoffending</i>	Disorder as dangerous as healthy	3
	Healthy more dangerous than disorder	25
<i>Treatability and treatment willingness</i>		45
<i>Empathy</i>	Harsh or unempathetic language	18
	Expressing empathy for defendants	23
<i>NOTE: Codes at depth 0 represent broader topics discussed, whereas those at depth 1 are sub-categories within those topics. The count represents the number of excerpts marked with each code.</i>		

3.3.1 Perspectives on behavioral determinants and moral responsibility impact decision-making

Perspectives on the origins or drivers of behavior, and corresponding ideas regarding the degree of moral responsibility assigned to defendants, emerged as important factors in judges' decision-making. This first category encompassed discussions of judges' understanding of behavior as being driven by factors such as individuals' own choices versus chance occurrences ('Choice and control', 'Luck'), or biology or the environment ('Free will and determinism'). These perceptions were

linked to varying degrees of assigned 'Blame and responsibility' and expressions of 'Empathy.' Discussions within this category also concerned understandings of behavior in cases with versus without mental health evidence.

Judges discussed the degree of control that individuals possess over their behavior, with a majority of judges expressing that individuals do not have full control over their actions ('Choice and control') or that chance plays a big role in how individuals are shaped and ultimately behave ('Luck'). Judges expressed that they "don't think anybody has full control" (J12) or that "For any individual person that gets born, luck and chance play a huge role, like ninety percent. You know, what family did you get born into? What country were you born in?" (J07). Such views were linked to an empathetic and non-retributive stance towards defendants that were seen as less blameworthy ('Empathy', 'Blame and responsibility'). One judge, speaking of 'Choice and control' and the idea of retributive punishment, expressed their opinion that "behavior is generally outside of the individual's control, and it should be our job to try and shape behavior to make it better without focus on retribution" (J34).

Judges also discussed their understanding of specific drivers of behavior based on scientific understandings of human biology ('Free will and determinism'). One interviewee explained how expanding the scientific understanding of behavior enhances empathy: "The more you see people as in some ways a function of their several brain structures and their connections, it's easier to have empathy" (J13). Corresponding to nuanced ideas regarding choice and behavioral control, judges generally leaned towards the idea that people may have at least some freedom of will. A prominently voiced idea in the interview data was that people's behavior is not fully determined and that individuals have at least some freedom of will ('Free will and determinism'); therefore defendants ought to be held responsible for their actions ('Blame and responsibility'). Those that opposed a deterministic understanding of behavior expressed mostly prudent views regarding blameworthiness, such as that "It depends on the circumstance, but while a lot of people don't have certain opportunities, people still make willful choices and put themselves in certain situations, so most people have full responsibility" (SC02) and recognized that "the environment has a huge impact on people's reactions but ultimately they do have free will to serve. Just because you're led by negative things doesn't mean that you have to act negative as well" (J30). Some judges expressed firmer belief in free will and the idea that "we are in charge of our destiny, it's not a matter of chance, there is free will. People have control over their destinies, and they have control over doing the right thing versus the wrong thing" (J33).

With specific regard to mental health evidence, many judges expressed the view that mental disorders exert irrepressible influences on behavior ('Choice and control'), and thus should serve as mitigating to sentencing by reducing the individual's blameworthiness ('Blame and responsibility'):

I think a healthy offender is more in control of the situation and their behavior [compared to someone with a mental disorder] I would expect the health offender to be able to control his impulses or her impulses better than somebody who is suffering from a disorder (J27).

Judges also discussed defendants as having irrepressible negative environmental influences on their behavior:

Repeat offenders [...] have had traumatic experiences that have been so pervasive that they may as well be genetic. For the most part, folks are coming from very difficult backgrounds. Sometimes immigrants from places where they saw their families murdered, or people who grew up in foster care abandoned. It's gonna take that person an enormous amount of courage and resources to heal (J11).

Whether mental disorders were viewed as mitigating appeared to be related to judges' views on determinism. Judges were more sympathetic ('Empathy', 'Blame and responsibility') towards defendants they see as being influenced by their biology ('Free will and determinism') and this was true for both brain disorders and life-course mental health issues stemming from trauma, with one judge expressing that "Once I hear evidence of a psychiatric issue, I tend to be sympathetic or empathetic to both sides in the situation" (J19). When it came to defendants with mental disorders, strong belief in free will ('Free will and determinism') appeared to be related to a lack of empathy and increased punitiveness ('Empathy', 'Blame and responsibility') towards all defendants, while judges in the middle of the free will-determinism spectrum were more likely to express increased empathy towards defendants with mental health problems compared to healthy defendants. Interestingly, a strong belief in

determinism appeared to be linked to treating all defendants with similar levels of empathy, regardless of whether they experience mental disorders:

It is all a spectrum but I don't think anybody has full control. I even would have empathy and understanding [for people that are healthy and well off], there are rich kids that do very well in life, and rich kids that do very badly. There's definitely a factor of no self-control even in those completely healthy situations (J12).

Ultimately, the level of blameworthiness and moral responsibility assigned to defendants appeared to be related to judges' beliefs regarding the degree to which individuals author their own behaviors versus being influenced by internal and/or external factors in a deterministic manner. Nevertheless, judges held that their jobs as decision-makers were not primarily concerned with the origins of behavior, but that when it comes to scientific evidence, their decisions ought to be focused on legal standards pertaining to factors such as the individual's future dangerousness and amenability to treatment.

3.3.2 Attitudes towards scientific evidence impact decision-making

A second major category that emerged concerned practical considerations around the relevance and informativeness of scientific evidence concerning criminal acts. Judges discussed their confidence in science and expert testimony concerning behavior or mental health ('Attitude towards science'). They also questioned the applicability and relevance of scientific evidence to particular acts ('Disorder relevance') and voiced their concerns over scientific explanations of behavior being used to excuse acts that are not seen as inevitable ('Excuses or expressing skepticism about psychiatric diagnoses').

Judges generally expressed confidence in the quality of scientific evidence and expert testimony in relation to mental disorder evidence ('Attitude towards science'). Nevertheless, they also questioned the applicability of scientific evidence in the practical applications of the law ('Disorder relevance'). When evidence of biological or environmental influences on behavior is seen as strong, judges appear to see such evidence as reducing blameworthiness and serving as mitigating to sentencing. However, judges questioned the relevance of mental disorder evidence to specific criminal acts ('Disorder relevance') and expressed being "interested in the link between the disorder and the conduct. So, the relevance of the disorder, I suppose. My first question is, is there a causal relationship between the [disorder and the crime]" (J29). Some skepticism was expressed regarding the credibility of psychiatric evidence and the extent to which science is informative within the sentencing context:

The question ultimately is, what the impact [of scientific evidence] is on the decision and that's going to vary from case to case. Credibility of the claim [that there is a mental disorder]. Causation [between the mental disorder and the criminal act] (J14).

I don't think it gets me anywhere to consider the origin of a disorder. Instead, what gets me to the place I need to be is, does evidence-based practice tell me there is an effective treatment? (J06).

While judges do welcome science in the courtroom and find that scientific knowledge is pertinent to criminal behavior ('Attitude towards science'), they also questioned its direct applicability to specific cases ('Disorder relevance'). Judges indicated that scientific evidence is important; yet, they only allow it to influence their decisions when this evidence directly relates to the specific conduct in question, effectively looking for a causal link between a particular diagnosis and criminal charge. Nevertheless, judges expressed that they trust and welcome science in their courtrooms and especially welcome scientific evidence when it pertains to possible concrete factors such as prior and potential treatments:

Generally, I think [scientific information on behavior in the courts] helps. I think that we need all the information that we can get, but what weight I give to it varies from case to case, but both the State and the defense need to present whatever science evidence that they think will assist me in making the correct decision (J15).

Moreover, judges expressed concern over claims of mental health evidence being used as an "excuse" (J30; 'Excuses or expressing skepticism about psychiatric diagnoses'), especially in the absence of clear-cut, major psychiatric diagnosis:

As a society, we should not use scientific evidence as an excuse for every behavior. I think scientific evidence can be very persuasive and there are risks in terms of misuse and junk science, and so it needs to be carefully monitored by a judge, whether a judge is deciding the issue or a jury is hearing these issues (J04).

Judges expressed that “Very few State Court judges probably have scientific training or anything like that” (J11) and are thus indicated that they may be prone to assuming that evidence of a mental disorder is not a sufficient justification for engaging in criminal behavior:

I don't know the effects of trauma on the brain, or mood, or emotions, or decision making, or anything at all. [...] I don't know that I have enough information or knowledge to say I definitely know that even if you have [a mental disorder] it affects behavior or criminal conduct (J03).

Judges also expressed that when scientific evidence is presented as additional information to explain defendants' behavior, it is “a good thing [...] the more information that you have to make a decision, the better decision that you can make” (J30).

3.3.3. Biases and scientific misconceptions impact decision-making

A final axial coding category comprised influences arising from cognitive processes that could give rise to biases ('Biases and scientific misconceptions') or result in misconceptions regarding defendants' dangerousness ('Dangerousness and reoffending') or their potential for rehabilitation ('Treatability and treatment willingness'). In discussing the factors that they consider in and may influence their decision-making when faced with scientific explanations of behavior, judges expressed several thought processes and viewpoints influenced by aspects of cognition and memory.

Judges' said they were influenced by readily available memories of negative, rather than positive outcomes, that shaped their wariness of particular risk factors for offending ('Biases and scientific misconceptions'). One judge stated that “Sometimes I might come across harsher because I've seen outcomes. I've seen certain behaviors that are predictive in my mind of bad future outcomes. And so I'm just on guard on some things” (J32). Moreover, personal experiences were found in some cases to influence judges' opinions. A judge who described their own personal experience with childhood trauma explained being aware that “perhaps for this reason I have learned this, and I have more sympathy for people that have experienced trauma and maybe need to turn things around for themselves” (J11). One judge explained that having “adult daughters, if someone killed my daughter, I'd want to kill him” (J01). Others also described how being a parent affects their decision-making when faced with relevant situations in their courts:

I have children and I have difficulty putting on my clinical hat when it comes to people who harm children. I concede that, it takes more work to put on your clinical hat and think through objectively and not bring down your hammer (J12).

Furthermore, judges stated that witnessing victims being in distress also affected their decision-making process in some cases. One judge explained that “If the victim's family is there and the mom gives a really emotional testimony and the family is in a very bad place, that will make me think, well, life has to be worth something” (J25). Empathetic distress in light of victims' persuasive testimonies seems to affect judges by motivating them to eliminate both their own distress and the victim's, even when they are aware of this extraneous influence on their decision-making:

There is [a] type of aversive empathy, with not wanting to experience and see these victims getting more and more angry. We have an aversion to seeing that emotional response [some judges might] start making your decisions so to avoid seeing a negative reaction or outrage (J12).

Judges also described specific beliefs rooted in gender roles and family structures, particularly in relation to children's upbringing. One judge discussed failures of parental supervision of boys and expressed concern that “The young men don't have a model to look towards” (J20). Others expressed concern over the breakdown of the nuclear family or specific beliefs that there exists a causal relationship between the absence of a father figure and future criminal behavior:

I'm going to sound very old-fashioned, but traditional family structures work. [...] That single parent had a child at a young age, or came from a poor family, they're struggling to put food on the table, keep a [...] roof over their head. There becomes then a choice. What do I do, do I go to work, or do I supervise my kid? You need to do both and if you don't have two parents, that makes it more likely that perhaps that child will become involved in the [criminal justice] system. Especially boys, because if you're a single mother, there's going to be a point when that it reaches puberty and it is going to be very intimidating (J21).

Indeed, interviewees commonly emphasized the belief that individuals' environment is what ultimately shapes their behavior and that when it comes to criminality "there's very few monsters that are just born. I think monsters are made, for the most part, through their environment" (J03). This viewpoint prioritizes environmental influences, such as traumatic experiences, as primary causes of problematic behavior and criminal justice involvement.

Prior negative experiences with specific criminal cases that readily came to mind also tended to inform assessments of dangerousness or whether an individual is likely to reoffend—leaving less room for newly presented and relevant scientific information to inform such decisions ('Biases and scientific misconceptions', 'Dangerousness and reoffending'). For example, judges that preside over cases in specialty courts such as veteran's courts, seemed to be heavily impacted by those experiences and expressed increased empathy and more favorable assessments of future dangerousness specifically towards defendants with traumatic experiences.

Personal experience also came into play when assessing the importance of mental disorders as risk factors for future criminal behavior. One judge recalled how their appraisal of defendants' traumatic life experiences was shaped by their own experience as "a lawyer in the army. I don't think I'll automatically think of a veteran on the street as dangerous. Even if you're a killer, you had this training, this experience, I get it" (J16). This type of familiarity with one type of mental disorder over others was common in the interview data, as judges in this sample presided over different courts and reported a multiplicity of personal experiences with particular types of mental disorders.

When discussing their appraisals of mental disorder evidence, judges appeared to deem some disorders, particularly those influenced by past experiences such as trauma, as posing a greater risk as compared to having no disorder—even if individuals with a history of trauma were viewed empathetically and considered to have some level or degree of reduced responsibility over their actions:

But after that [natural disaster] experience, I had some insight into how involuntary and automatic the response can be, and how out of control I was as I was responding. So that gave me a lot of sympathy. Now, translating that into sentencing, you know, it's a two-edged sword. Yes, [trauma-induced negative behaviors] are involuntary, but it's also almost predictable it is that it's going to happen again (J01).

Defendants without mental disorders were generally considered less unpredictable and hence less dangerous than defendants with mental disorders. Many judges conveyed worry about the violent and dangerous traits associated with specific types of disorders, describing that in their experiences, "schizophrenia is a pretty bad disease, and you do tend to see some violent acts of people with schizophrenia" (J10). Such associations between psychotic disorders and dangerousness appeared to make it more likely to drive judges' preferences towards incapacitation as "a paranoid schizophrenic who I think is more dangerous, I have to consider putting him away" (J32).

Despite finding that "it's disturbing to think that it's okay to lock up someone with mental health issues" (J32), judges conceded that there are no adequate solutions to readily consider treatment instead of imprisonment, as they are faced with exceedingly long waiting periods "before the bed [in a treatment facility] opens up for [a defendant with a mental disorder] sitting in the county jail" (J32). One judge discussed how other actors within the criminal justice system hold similar beliefs regarding mental disorders by describing a jury's reaction to the idea that "This person has committed this horrible crime, oh and bonus, they're crazy. The jury is going to be much more likely to convict and that's when it flips from mitigating to aggravating, because of the [perceived] dangerousness" (J29).

More than half of the judges in our sample expressed at least at one point during the interview that an offender with a mental disorder is likely more dangerous than an offender without a diagnosis, who may be more in control of their behavior and be able to enact of behavioral changes. Many of these views were tied to considerations regarding amenability to treatment:

Someone with a diagnosis may be more dangerous without treatment because of an inability to control one's behavior when they are untreated, they can be more dangerous than someone that is stable or all together healthy. But I think generally it just depends on how receptive to treatment a specific person is (J14).

Still, some judges mentioned that they believed offenders without mental disorders were equally as dangerous as those with disorders. Many sentiments included scientifically informed understandings of dangerousness and the likelihood to reoffend, in which the criminal history and motivations to commit a crime are more important predictors than a mental disorder diagnosis. This position was especially true for judges when considering traumatic disorders: “I don’t think trauma makes you more dangerous, we have plenty of people that have PTSD [Post-Traumatic Stress Disorder] it may make them more apt to react violently in certain situations, but I don’t think that makes them inherently dangerous” (J31).

Certain conceptions based on scientific knowledge played a role in judges’ views on defendants’ potential for rehabilitation (‘Biases and scientific misconceptions’, ‘Treatability and treatment willingness’). When presented with a mental disorder diagnosis, judges grappled to appraise how the relevant science can inform the chances of an individual continuing to pose a risk to society versus being successfully treated. For example:

If we’re talking about a healthy person, absolutely they can change their behavior. This is unscientific, but criminal punishment or jail or the stark reality of probation can be a cold slap in the face that makes you very uncomfortable and suddenly you can be different (J16).

Moreover, judges in our sample expressed ideas that were based on their interpretation of scientific knowledge regarding the nature or effects of mental disorders. One prominent belief concerned differences between disorders that may be present at birth (innate) and disorders that may be associated with certain life experiences (acquired). Some judges considered innate disorders as having a more severe and lasting impact on behavior and saw innate disorders as difficult to overcome. Judges most commonly considered individuals with innate disorders to be more dangerous than those without a mental disorder and the reasoning that most relied upon was believing that someone with an innate issue was less amenable to treatment:

It depends on the kind of behavioral disorder and innate disorder, but a person that has an organic type of issue, an innate issue, may be less amenable to treatment, while perhaps someone who had an acquired disorder like PTSD may be more amenable to treatment (J04).

Judges expressed the idea that someone with a disorder could be treated to overcome a specific ailment, while a person without a disorder has fewer options in terms of rehabilitation:

I would be inclined to say the mentally ill person is less dangerous [than a healthy person], because there's different things that are going on. And there's more opportunities to help somebody that has something going on. A regular or typically developing persons is, you know, I have to rely on them to fix themselves, and they don't usually get as much intervention (J07).

Ultimately, our data indicated that a major influence on judges’ decision-making appears to be the bottom line of the future risk the individual poses to the community, and a need to “protect society from the monster that it itself has created” (J26). Judges emphasized that their focus “as a judge is protecting the community. [This] is at the top of my list. If I have to protect the community, I’ll put someone that is dangerous away for as long as I need to” (J15). The risk posed by defendants, and any scientific evidence concerning defendants’ amenability to treatment, thus was reported to be influential to them and “most judges will tell you that the principal issue that we’re looking at is public safety” (J08), rather than scientific understanding of defendants’ behavior and moral responsibility.

Discussion

This study probed the opinions and attitudes to elucidate the decision-making processes of judges relevant to bio-behavioral scientific evidence during criminal sentencing processes. NLP uncovered overall more positive, as compared to negative or neutral, sentiments in the interview data and indicated that judges focus on different considerations when discussing scientific explanations of behavior based on personal characteristics such as their age, prior work, and beliefs in determinism. Our qualitative analysis broadly aligned with NLP results and identified themes that fit into three categories of considerations that may impact judicial decision-making, namely, behavioral determinants and moral responsibility considerations, general attitudes towards scientific evidence, and cognitive biases and relevant scientific misconceptions. We synthesize these findings derived

from a combination of methodological approaches and discuss the implications of our analysis for the future of judicial education and science communication in criminal proceedings.

The sentiment analysis conducted uncovered overall more positive, as compared to negative or neutral sentiments in the interview data. Most notably, negative sentiments were most commonly expressed among judges whose entire prior career consisted of prosecutorial work. Given that interview topics were focused on questions regarding considerations of scientific evidence as explanations of behavior, negative sentiments may denote a pessimistic or contesting stance regarding the informativeness or relevance of such evidence, or the overall utility of incorporating scientific understandings of behavior into legal decision-making. That former prosecutors would rely on their training and experience and have a less favorable attitude towards integrating scientific findings into their reasoning aligns with prior research examining the potential influences of a prosecutorial background on judicial decision-making (24, 54, 55). For instance, prosecutors are less likely to focus on mitigating evidence during sentencing and have been found to be less empathetic towards defendants with mental disorders, while also endorsing more stereotypes based on scientific information (24, 55). Still, overall, the sentiment analysis highlights an inclination on the part of the majority of judges to be accepting of scientific explanations for behavior and adopt such approaches in their decision-making. Indeed, the STM results showed that discussions among former prosecutors focused more heavily on legal, practical, and procedural topics, such as sentencing laws and incarceration, as opposed to more philosophical aspects of punishment or moral considerations drawn from scientific explanations for behavior.

Moreover, the key areas of focus identified through the topic model indicate that several differences may exist in the decision-making process of judges based on their sociopolitical views. Most notably, interviews with self-reported conservative judges and those located in Southern states centered around considerations over defendants' dangerousness and secondarily on amenability to treatment. Indeed, it has been shown that bio-behavioral scientific evidence in the legal context is more likely to be accepted if it aligns with decision-makers' prior beliefs, or interpreted in a way that confirms preexisting views (56). At the same time, research indicates that conservative and liberal ideologies rely on different sets of moral standards (57), with conservatives traditionally supporting more authoritative crime control objectives underpinned by notions of retributivism (58). At the same time, majority conservative states have also been less likely to adopt rehabilitation models of criminal justice (59) and there is some research to suggest that conservative judges and juries may be less likely to view mental disorders as mitigating (24, 60). It follows, then, that for judges with underlying knowledge associated with Southern values or sociopolitical conservatism (61–63), scientific understandings of behavior or the presence of mental disorders may in some way be more likely to trigger considerations of dangerousness and future risk to society, as opposed to the rehabilitative aims or more philosophical ideas around moral responsibility and punishment.

Those who reported beliefs in free will were also found to emphasize issues of dangerousness, while judges with deterministic views of behavior were more likely to discuss philosophical and moral implications of scientific understandings of human behavior. This finding was further supported by qualitative analysis of the interview data. Whether mental disorders were viewed as mitigating appeared to be related to judges' understandings of determinism and judges were more sympathetic towards defendants when they viewed them as being influenced by their biology. More specifically, judges holding the most conservative views and expressing the strongest beliefs in free will appeared to show lower levels of empathy for all defendants, including those with mental disorders, based on their understandings of behavior as always being controlled by the individual and not "determined" by their biology or external factors. This involved seeing people with mental health disorders equally responsible and in control as those who did not have any mental disorder.

This influencing role of existing beliefs regarding the scientific basis for behavioral control may provide a partial explanation for previous findings of increased punitiveness being associated with conservative policies and justice systems in majority conservative states (30, 64–66). On the other end of the spectrum, judges expressing a deterministic understanding of behavior held that no individual has full control or full moral responsibility for their actions. Thus, a lower attribution of moral responsibility may thus act as a mitigating influence to sentencing considerations across all defendants, potentially leading to sentencing practices that are more likely to focus on diversion and rehabilitation of individuals with mental disorders (29, 58, 67, 68).

The most common viewpoint among judges in our sample on free will and determinism was positioned in the middle of the spectrum—with luck and determinism having some impact on their views, but also them maintaining that people generally do have some control over their behavior. Judges holding this understanding of human behavior were more likely to view mental disorders as mitigating and exhibited more empathy and less punitiveness towards defendants who may present scientific explanations for their behavior. Stemming from the interview data, these views appear to be based on their understanding that defendants with mental disorders have reduced control and consequently reduced responsibility over actions that are, to some degree, “determined” by their disorder (26). This viewpoint is in line with a large body of bio-behavioral research indicating that some mental disorders may exert an apparent, observable, and sometimes detrimental influence of behavior (10, 12, 69–74). Importantly, however, our finding that most judges appreciate the mitigating role of mental health problems does not align with the practical reality of sentencing outcomes in the U.S., as sentencing outcomes have not been found to be, on average, less punitive for defendants with mental disorders (20, 75–77).

Notwithstanding the moral considerations arising from scientific insights into behavior, judges overall expressed being primarily concerned with the practical applicability and relevance of bio-behavioral scientific evidence in criminal cases. Previous studies have shown that the relevance of mental disorders is often questioned when adjudicating a specific criminal act (75, 78). Moreover, when bio-behavioral scientific evidence is considered relevant to a case, judges appear to often prioritize its informativeness in the practical, rather than the moral, realm—incorporating scientific considerations of dangerousness and treatability into their decision-making as shown in previous research (24, 25). These findings may shed some light onto the “double-edged sword” phenomenon that postulates that mental disorders can lead to either more lenient sentences, due to the more philosophical considerations of reduced culpability, or harsher sentences, due to perceived danger or lack of amenability to rehabilitation (19, 20, 66, 79).

Bio-behavioral research into the potential dangerousness and risk posed by individuals with mental health disorders is as varied as the wide range of mental disorders and their behavioral effects (80); yet those in U.S. society, including members of the judiciary, are known highly stigmatize individuals with mental health conditions (44, 81). The very nature of cognitive functioning in humans—a system that puts efficiency above accuracy in its continuous effort to categorize, connect, and label information—inevitably, or by design, leads to cognitive bias; this is especially true when humans are faced with complex or unfamiliar information and are asked to make decisions based on it, such is the case when criminal court judges are presented with scientific explanations for behavior (82).

In the present study, we identified numerous thought processes and judgments that seem to be influenced by cognitive biases, with stereotyping being one such influence. For instance, defendants without mental disorders were generally considered less unpredictable and hence less dangerous than defendants with mental disorders, and judges expressed concern over innate mental health conditions being more permanent and difficult to treat. These notions have previously been connected to common essentialist biases marked by the constructs of continuity and immutability (83–85). In this context, stereotyping and essentializing features of disorders seem to play a role in affecting judges’ decision-making, which supports findings of prior research on the cognitive biases found to affect the deliberations of judges and the public (24, 35, 44).

Moreover, judges appeared to be influenced by salient and readily available memories of events or personal experiences that have shaped their wariness of particular negative outcomes and risk factors for offending. These influences seem to align with the use of the availability heuristic or with a familiarity bias, as relying on information that easily comes to mind is a cognitive mechanism that introduces bias and blocks the potential for considering other, more pertinent information (86). Empathetic distress, the cognitive-emotional phenomenon of experiencing another’s anguish and making biased decisions to escape this involuntary negative state (87), also appeared to influence judges—with them expressing an often explicit aversion towards witnessing the distress of victims or the community at large. Indeed, it has been argued that empathy, in this sense, can lead to cognitive distortions by narrowing a judges’ perspectives, causing them to overemphasize a single perspective over others (88, 89).

It is important to note that cognitive biases and the use of heuristics are among the most human attributes and have been observed as common psychological phenomena that transcend social, cultural, and educational backgrounds (90, 91). Therefore, it is expected and natural for judges to make use of heuristics or exhibit cognitive biases when faced with complex

information about human biology or behavioral science. Criminal court judges take advantage of educational opportunities, and this study has shown that they generally possess a developed understanding of human behavior and look to consider biological predispositions and environmental influences on defendants' behavior. Overall, to help understand and aid judges in their decision-making processes, research should strive to examine and better understand cognitive bias in decision-making and its effects on sentencing determinations.

This study did face limitations. The conclusions of this study may not be generalizable to the entire population of U.S. judges. The participant sample used here is sufficient for qualitative research (44, 46), but this sample includes judges from only one-third of U.S. states, with a potential overrepresentation of judges that are not religious or are socio-politically liberal. Our sample may also overrepresent judges who decided to participate in the interview because of a preexisting interest in the topics of science or mental health. As such, it is unclear whether the views expressed in our interview sample would differ from other judges. Future studies using judicial samples may need to explore ways to reduce sampling bias or by utilizing more purposeful sampling methods.

While the incorporation of NLP in the present study is, at least in part, an effort to overcome the generalizability and interpretive variability limitations of qualitative research, NLP also faces limitations. It should be noted that among the variables used as NLP parameters, certain categories had small sample sizes, such as participants aged 70–80 or some of the prior work categories. Still, the STM results provided valuable insights into the focus and direction of conversations with different judges, despite being guided by set interview topics and questions. Moreover, the use of positive language as detected by sentiment analysis does not directly correspond to empathetic sentiments towards defendants or victims, nor do lower sentiment polarity scores indicate negative views on one particular topic. Rather, sentiments are likely related to an overall positive or negative stance throughout an interview (38) or for example, expressing optimism or approval of the particular concepts and topics discussed within each interview. Because the broader context is important in drawing conclusions regarding where particular sentiments were directed towards, the qualitative analysis conducted in addition to NLP helps to elucidate particular ideas that judges discussed in a positive or negative light.

This study has significant implications for a criminal justice system increasingly permeated with bio-behavioral scientific evidence. Judges are increasingly called upon to evaluate and apply complex bio-behavioral scientific knowledge in cases involving mental disorders and beyond (92, 93). The findings of this study highlight that judges actively engage in efforts to assess scientific information, but this task is arduous for legal professionals. The inherent interpretive difficulty posed by bio-behavioral explanations for behavior is particularly relevant in the context of the Daubert standard, which requires judges to act as gatekeepers, ensuring the reliability and relevance of scientific evidence presented in court (4, 6). Given the apparent challenges judges face as they process scientific information through their own cognitive filters, as also shown in previous studies (31, 44), a critical question arises: how can the criminal-legal system equip judges with the requisite scientific knowledge as mandated by the Daubert standard?

This points to a need for enhanced science education within the judiciary to better prepare judges and provide them with the skills necessary to competently handle bio-behavioral scientific evidence. While all judges who participated in this study reported having attended multiple educational events related to science or mental health evidence, the number of opportunities available to them and the content of curricula varied widely. The sheer diversity of educational backgrounds and training opportunities within our sample indicates a serious lack of standardized approaches to the scientific education of the judiciary, which could potentially lead to inconsistent sentencing outcomes that compromise the uniformity of sentencing (94).

Another implication of our findings extends beyond the criminal legal system and necessitates the establishment of cross-disciplinary initiatives for the communication of scientific knowledge into the criminal justice system. While all judges who participated in this study reported having attended multiple educational events related to science or mental health evidence, the number of opportunities available to them varied widely, as well as their prior educational backgrounds. This fragmentation of scientific education can lead to inconsistencies in the evaluation and application of scientific evidence in court proceedings, ultimately impacting the fairness and efficacy of the justice system (95). Therefore, there is an urgent need for collaborative efforts between the fields of law and science to develop comprehensive and standardized ways of communicating scientific facts in legal proceedings (96). This may equip experts with the multidisciplinary tools that can help explain the relevance of

scientific evidence to criminal cases (97), an issue that appears central in judges’ decision-making process when considering scientific explanations of behavior. Scholars have also advocated for the use of mitigation specialists, whose role can involve the acquisition of pertinent information regarding influences on a defendants’ behavior, including navigating the complexities of relevant scientific evidence, and providing critical support to the judiciary (16). As criminal justice evolves in response to advancements and increased dissemination of science, the integration of multidisciplinary roles like that of the mitigation specialist becomes imperative.

Finally, our research has potential methodological implications that could help to pave the way for future research based on textual data. In the present study, NLP-based analysis pinpointed the themes that warranted in-depth exploration using qualitative techniques. The computational qualities of NLP, thus, can introduce possibilities for fine-grained quantitative text analysis that can help identify major themes present in the interview data for subsequent qualitative analysis; this can ultimately lead to more robust results that may overcome some of the limitations that qualitative and quantitative methods face when used alone, such as generalizability or interpretive variability and contextual blindness or interpretability. (37, 41, 98). By systematizing this type of approach and learning from previous literature on mixed methodologies (41) future studies on judicial reasoning could leverage the strengths of both quantitative and qualitative methods.

Conclusions

Although judges appear to generally welcome scientific knowledge into their courts, they may approach such evidence with skepticism as well as be influenced by experiences and prior knowledge that can shape their cognitive filters and decision-making processes during sentencing. The criminal justice system ought to endeavor to mitigate or standardize these influences on judicial decision-making. The present findings exemplify the need not only for further research on these topics, but also for a dynamic and adaptable approach to criminal justice policy—one that remains responsive to the accelerating pace at which scientific knowledge permeates the courts.

Abbreviations

FAD-Plus: Free Will and Determinism Plus scale

GBMI: Guilty But Mentally Ill

LDA: Latent Dirichlet Allocation

NGRI: Not Guilty by Reason of Insanity

NLP: Natural Language Processing

PSI: Pre-Sentence Investigations

PTSD: Post-Traumatic Stress Disorder

STM: Structural Topic Modeling

Declarations

Ethics approval and consent to participate

The Rutgers University Institutional Review Board (IRB) approved the study. All participants provided informed consent prior to participation.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests

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Authors' contributions

MT collected, analyzed, and interpreted the data. MT and CB designed the interview guide and developed the methodology. SX contributed to the qualitative component of the study. All authors contributed in writing the manuscript. All authors read and approved the final manuscript.

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Figures

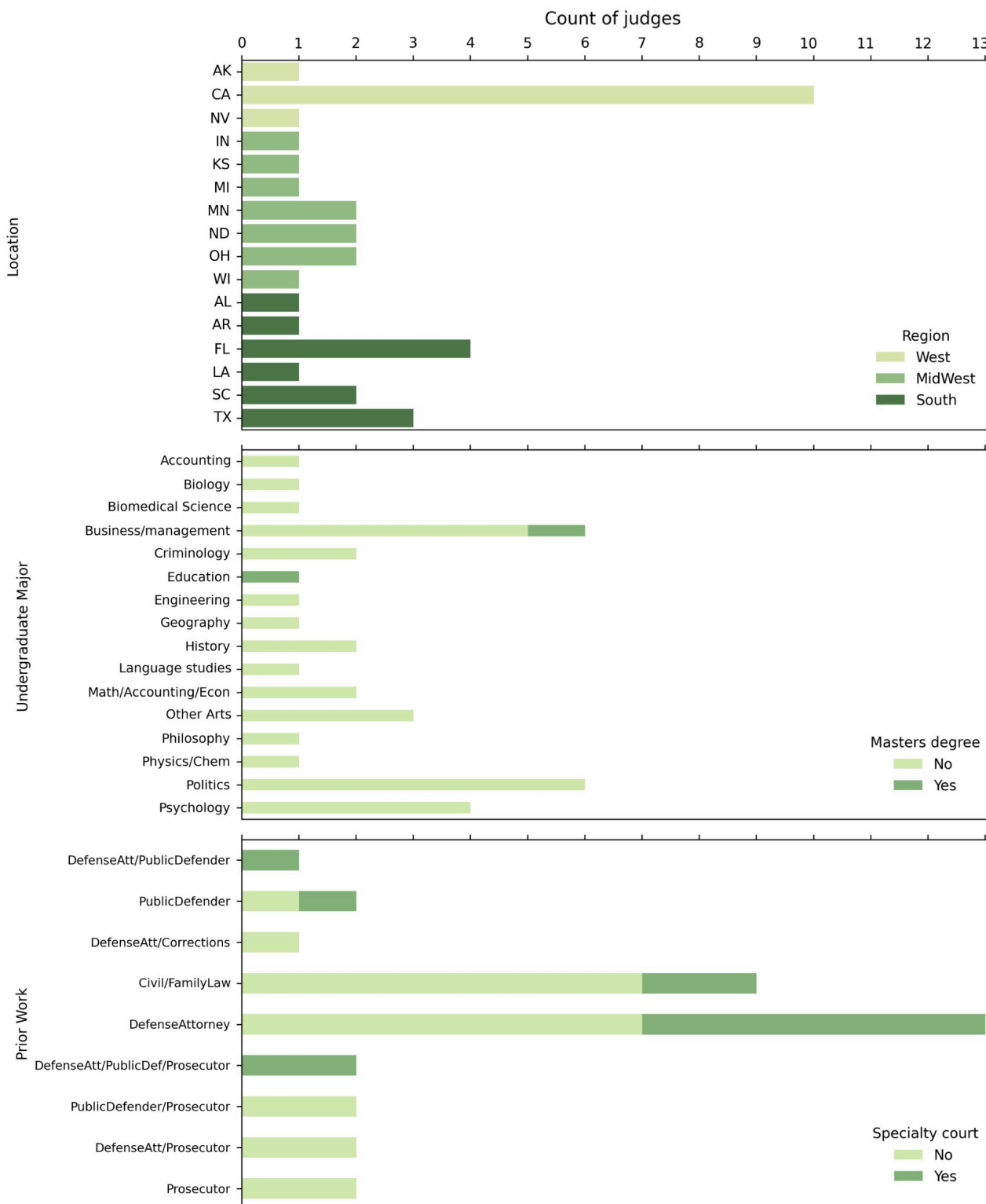


Figure 1

Summary of characteristics related to judges' state and region, educational background, as well as prior and current work.

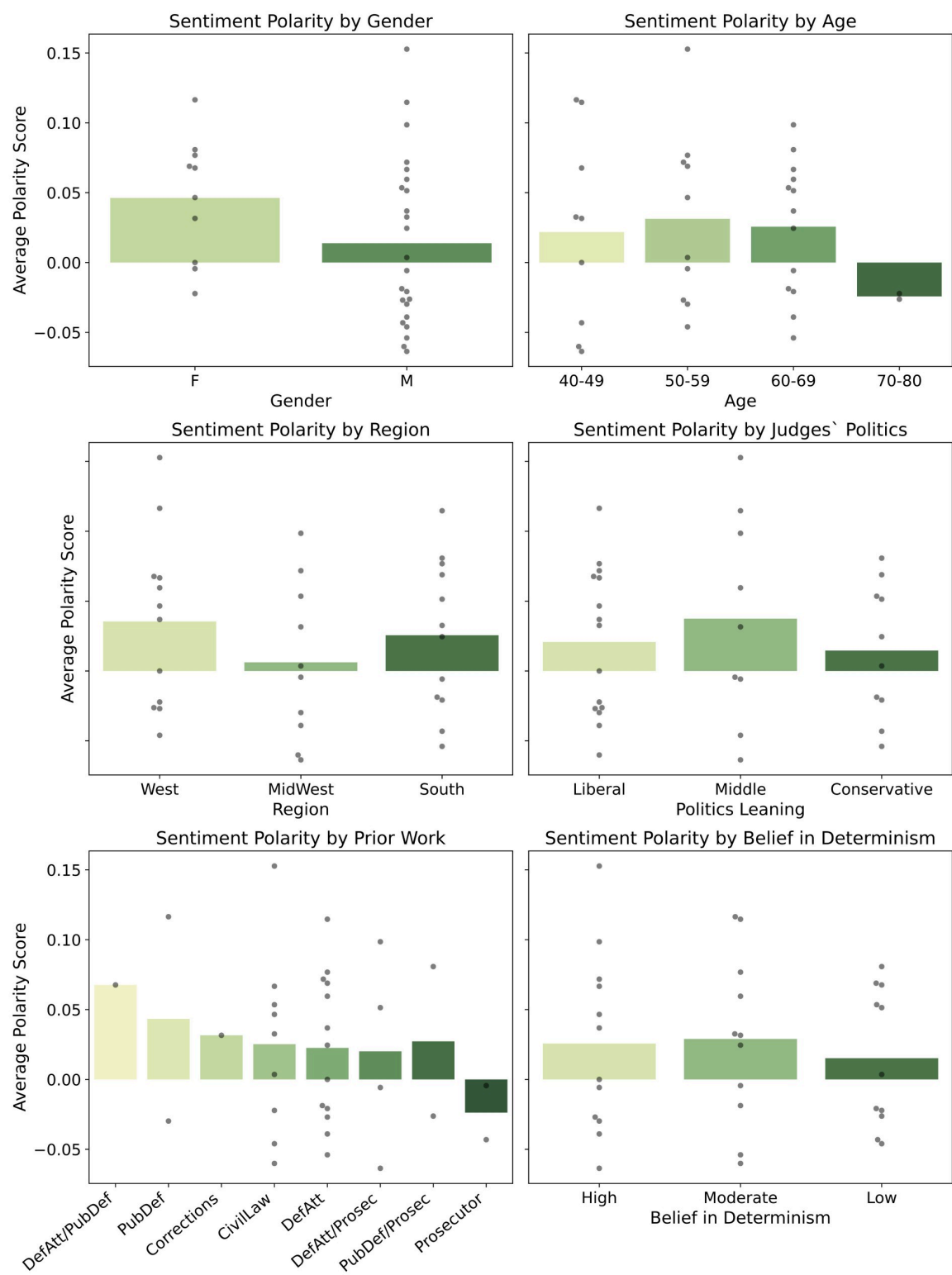


Figure 2

Visualization of the sentiment analysis, displaying average polarity scores between the categories of each of nine judge characteristics.

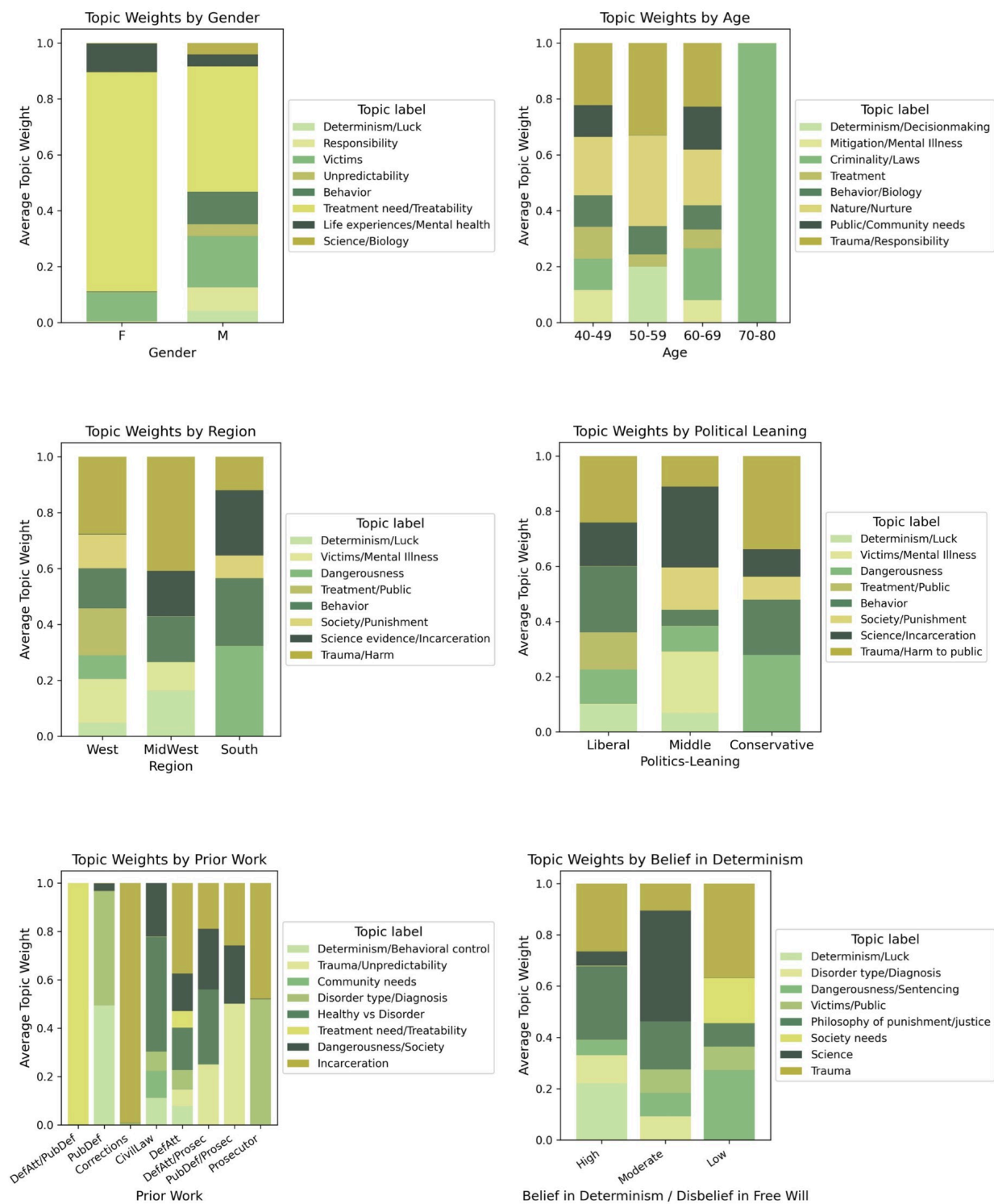


Figure 3

Visualization of the Structural Topic Modeling results, displaying average topic weights between the categories of each of six judge characteristics.

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