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Disgust and biological descriptions bias logical reasoning during legal decision-making

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Legal decisions often require logical reasoning about the mental states of people who perform gruesome behaviors. We use functional magnetic resonance imaging (fMRI) to examine how brain regions implicated in logical reasoning are modulated by emotion and social cognition during legal decision-making. Participants read vignettes describing crimes that elicit strong or weak disgust matched on punishment severity using the US Federal Sentencing Guidelines. An extraneous sentence at the end of each vignette described the perpetrator's personality using traits or biological language, mimicking the increased use of scientific evidence presented in courts. Behavioral results indicate that crimes weak in disgust receive significantly less punishment than the guidelines recommend. Neuroimaging results indicate that brain regions active during logical reasoning respond less to crimes weak in disgust and biological descriptions of personality, demonstrating the impact of emotion and social cognition on logical reasoning mechanisms necessary for legal decision-making.

Keywords: Disgust; Legal decision-making; Logical reasoning; Dehumanization.

Both reason and emotion interact in the legal domain. Legal scholars have claimed that legal reasoning is based on a rational deductive system, and is merely a form of deductive logic (Brewer, 1996; Cohen, 1916; Huhn, 2002). Logical legal decision-making has been the norm since the seventeenth century (Hoeflich, 1986), and today students interested in pursuing law must take a standardized test (LSAT) that almost exclusively probes logical reasoning ability. Actors in the legal system are also supposed to be logical—the jury functions as a finder of facts, making unbiased, logical choices relevant to the evidence presented at court, while judges, prosecutors, and police officers involved in legal proceedings are responsible for the logical, impartial implementation of legal code. Such attention to the logic of law suggests that legal decision-making, including inferring the defendant's mental states and assigning punishment, should be a strictly reasoned process. In fact, the Model Penal Code was developed to standardize how third-party decision-makers determine levels of culpability (Wechsler, 1952)—a mental state inference. This Model Penal Code requires third-party decision-makers to employ deliberative, reason-based *social cognition* to determine whether the defendant acted purposely, knowingly, recklessly, or negligently; it requires decision-makers to think logically about the intent of the person who committed the crime. Social cognition can be broadly defined as how people make sense of other people, including their thoughts and

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feelings, in order to navigate the social world (Fiske & Taylor, 2013), a necessary skill for the legal system. This places deliberative, reason-based social cognition at the forefront of legal decision-making.

However, the legal system evolved to guarantee a social contract (Rousseau, 1920), punishing those whose behavior violates moral and legal codes. As such, moral emotions like disgust are relevant to legal decisions, and may have influenced the establishment of legal code. The role of emotions in the law has, until recently, been underappreciated, with a shifting perspective regarding the importance of emotions in legal decision-making (Abrams & Keren, 2009; Hanson, 2012; Maroney, 2006).

Research demonstrates that logical reasoning can be affected by emotion, inhibiting or enhancing legal decision-making. For example, emotions may inhibit legal decision-making since emotional subject matter reduces logical reasoning behavior and corresponding brain activity (Blanchette & Richards, 2004; Lefford, 1946). Racial prejudice research demonstrates that American judges show a moderate-to-large degree of implicit racial bias (Rachlinski, Johnson, Wistrich, & Guthrie, 2009) that may also negatively bias legal decisions. Stereotypes—automatic social cognitive heuristics that do not allow for the interrogation of an individual's individuating mental states (Neuberg & Fiske, 1987)—impair logical reasoning, creating an additional source of bias in legal decision-making. Conversely, studies demonstrate a vital role for emotion in legal decision-making; brain regions associated with emotional processing, such as the amygdala, can predict third-party punishment magnitude (Buckholtz & Marois, 2012; Buckholtz et al., 2008). Similarly, moral disgust reactions to crimes may enhance the legal decision-making process, since disgust can amplify the moral relevance of certain evaluations, specifically those that violate our moral sense of purity and the sanctity of the body (Horberg, Oveis, Keltner, & Cohen, 2009). Perhaps emotions like disgust readily trigger logical legal reasoning mechanisms, in turn enhancing cognitive processes involved in legal decision-making. Notably, however, several behavioral studies have demonstrated that gruesome evidence can lower the threshold of proof for conviction (Bright & Goodman-Delahunty, 2004; Kassin & Garfield, 1991), increase emotional arousal in a mock jury (Douglas, Lyon, & Ogloff, 1997), and enhance the perception of sufficiency for prosecutorial evidence (Bright & Goodman-Delahunty, 2006), suggesting that enhanced processing does not always lead to unbiased decision-making.

This study investigates how emotion and social cognition inhibit or enhance legal reasoning. Do mildly disgusting crimes and biological personality descriptions decrease reasoned responses in parts of the brain engaged during deductive logic when making legal decisions, or do they facilitate legal reasoning? Importantly, legal decisions cannot be separated from moral judgments and attributions (Hart, 2012; Schleim, Spranger, Erk, & Walter, 2011)—our moral codes directly influence the values and beliefs reflected in our justice system. That said, the neural processes underlying moral cognition in human beings are complex, integrating affect and cognition to reason about moral dilemmas (Moll & de Oliveira-Souza, 2007; Moll, Zahn, de Oliveira-Souza, Krueger, & Grafman, 2005). Moreover, complex facts about an individuals' behavior, such as attributions about his/her beliefs and the intentions behind behavior, recruit complex, integrative networks in the brain (Young, Cushman, Hauser, & Saxe, 2007; Young & Saxe, 2009). Although responsibility judgments and punishment decisions seem to be intertwined, they each represent different psychological processes during legal decision-making. Responsibility is an inference based on social cognition (Woolfolk, Doris, & Darley, 2006), and could be considered an "affective" response, since it represents a subjective evaluation (Monin, Pizarro, & Beer, 2007). Punishment decisions are based, in part, on affective processing, with motivations like deterrence, retribution, and restoration guiding punishment decisions (Gromet & Darley, 2006), but are still decidedly more objective evaluations that rely on distinct cognitive processes (Tassy et al., 2012).

Here we explore how disgusting crimes and personality descriptions of perpetrators affect decision-making and logical reasoning mechanisms underlying responsibility judgments and third-party punishment decisions, two distinct processes that are always involved in legal decision-making. We use a behaviorally inspired social neuroscience approach (Todorov, Harris, & Fiske, 2006) to discern whether disgust and personality descriptions affect decision-making and brain regions associated with logical reasoning. This allows us to see the impact of affect and social cognition on legal decision-making behaviors.

Third-party legal decision-makers must appropriately gauge the actions of another, tempering their own moral beliefs and adhering to the rational and objective standards of the law. Yet, the legal system provides an inherently dehumanizing context—decision-makers struggling to make objective choices may not think about the defendant's individuating mental states. Defendants on trial are often viewed as moral outcasts for having been accused of committing

disgusting crimes, and people frequently dehumanize disgusting others (Harris & Fiske, 2009). Moreover, the introduction of scientific evidence into courts of law may further reduce interrogation of the defendant's unique mental states, mitigating punishment decisions (see Aspinwall, Brown, & Tabery (2012) for this phenomenon in action on US state trial judges) and reducing blame (Kvaale, Haslam, & Gottdiener, 2013). Biological descriptions of personality may shift the focus away from the defendant's mental states and provide a deterministic account of behavior, "mechanizing" the defendant and perceiving him as an automaton that had no control over his actions (Haslam, 2006).

Both independent variables bear ecological relevance to the legal context and address whether a dehumanized perception (Harris & Fiske, 2009) can affect responsibility judgments and punishment decisions. Disgust is highly relevant to criminal cases—decision-makers are commonly presented with brutal and grotesque crimes, hearing detailed testimonies and seeing evidence infused with disgusting attributes; we hypothesize that this may inhibit logical legal reasoning during responsibility judgments, but facilitate logical legal reasoning when considering punishment. Moral character inferences (personality trait inferences) are crucial determining factors in attributing responsibility or culpability, and biological descriptions of personality are more frequently being introduced into courts of law; we hypothesize that biological descriptions of personality may inhibit legal logical reasoning during responsibility judgments, showing a decrease in brain activity consistent with a dehumanized response.

MATERIAL AND METHODS

Participants

Twenty-seven right-handed participants completed the functional magnetic resonance imaging (fMRI) study. Participants who did not answer 25% or more of the questions during the legal decision-making task were disqualified from analysis (seven participants), leaving 20 participants (10 males; mean age: 30 years, range 18–45; 6 ethnic minorities). Furthermore, 3 of the 20 participants were disqualified from the logical localizer analysis for scoring below 90% accuracy (accuracy rates = 80%, 78%, and 38%). This is because participants were extensively trained on this task and were required to perform at ceiling before scanning. This left 17 participants whose data derived the logical localizer region of interests (ROIs).

Paradigm

Vignette pilot

We created 100 criminal dilemma vignettes depicting the details of a perpetrator committing a crime ($M_{\text{WordCount}} = 47$). Vignettes fell into a strong or weak disgust condition and were matched on severity using the US Federal Sentencing Guidelines and the North Carolina Sentencing Manual. To preserve ecological validity, vignettes were not matched across specific behaviors, but rather based on consequence for the act that guides legal punishment standards (i.e., matched on aggravated assault, not the means by which aggravated assault occurred). This allows us to include the normal upward departures (increased sentencing) for crimes, such as serious bodily injury or possession of a deadly weapon, and allows for the natural variability in crimes that legal decision-makers often face. A vignette strong in disgust reads as following:

> Rob Whitley was on his lunch break. He saw his boss at the hot dog stand and approached him while taking out a pair of scissors. He stabbed his boss on the side of the neck first, and then the lower back, causing the victim serious blood loss and requiring hospitalization.

A vignette weak in disgust reads as following:

> John Noel was at a bar and saw his ex-girlfriend's new lover, James. Although John was not expecting to see James there, John took out the gun that he regularly carried from his back pocket and tried to shoot James, but missed.

Both of these crimes would be punishable for aggravated assault, and have an offense level of 19 on the Federal Sentencing guidelines.

Participants ($n = 11$) rated the moral reprehensibility of the act, the severity of punishment, and the extent to which each vignette elicited disgust on a Likert scale of 1–7 to ensure that the vignettes were matched. We removed eight vignettes that fell beyond the tails of the distribution and removed the counterpart vignette to match the number across both conditions, resulting in a total of 84 vignettes (weak disgust: $M_{\text{disgust}} = 3.54$, standard deviation ($SD$) = 1.21; strong disgust: $M_{\text{disgust}} = 5.33$, $SD = .87$).

Experimental task

We added a one-sentence explanation of the perpetrator's behavior to the end of each vignette, describing personality using either trait or biological

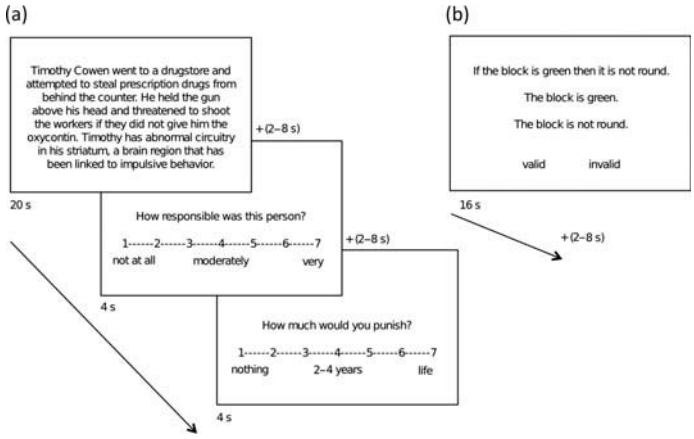

Figure 1. Depiction of legal decision-making task (a) and logical reasoning task (b).

language ($M_{\text{WordCount}}$ = 15**)**. This information did not explain the crime (e.g., "Gerald frequently proves to have an impulsive personality" versus "Terry has a gene mutation that has been associated with impulsivity" when the crime was premeditated murder). Thus, the legal decision-making task used a 2 (strong disgust, weak disgust) × 2 (trait personality description, biological personality description) within-subjects design. Each participant saw all 84 vignettes throughout the scanning session.

On each trial, participants viewed a screen with the vignette for 20 seconds (Figure 1(a)). The next screen presented the question "How responsible is this person?" with a 1–7 Likert scale beneath it. The final screen presented the question "How much would you punish?" with a 1–7 Likert scale beneath it. Since we used real punishment standards, punishment values were in ranges, mimicking actual sentences for crimes. The scale values were labeled as follows, with the numbers in the parentheses corresponding to the offense levels prescribed by the Federal Sentencing Guidelines and NC Sentencing Manual: "none", "1–60 days", (for Class 1 and Class 2 misdemeanors), "2–12 months" (8–10), "2–4 years" (17–20), "12–16 years" (34), "20–25 years" (38), "life", (43). Each vignette corresponds to one of these sentencing categories. The responsibility and punishment screens were presented for 4 seconds each. Participants responded by button press. A 2–8 second jittered fixation cross-separated each screen.

Localizer task

We used four formal arguments to create a series of 40 logical arguments using natural language for our logic localizer ROI task (Monti, Parsons, & Osherson, 2009). The formal arguments require the use of deductive logic; a type of logical reasoning that has commonly described legal reasoning (Huhn, 2002). Twenty arguments were valid, and 20 were invalid. Each argument consisted of two premises and one conclusion. Each trial showed three lines of text on one screen: premise 1, premise 2, and the conclusion. Participants had 16 seconds to determine whether the premise presented a valid or invalid argument. Participants responded by button press. A 2–8 second jittered fixation cross-separated each trial (Figure 1(b)).

Procedure

After participants gave informed consent in accordance with a protocol approved by the Duke University Medical Center Institutional Review Board, they read a short set of instructions on a computer. Participants then trained on the localizer task, and had to perform to ceiling before they could be taken to the scanner. If they failed, they underwent training again and were retested (no participants failed twice).

In the scanner, participants completed seven 8-minute runs of the legal decision-making task, then two 7-minute runs of the logic localizer. The vignettes were counterbalanced, so that if there was a trait description of personality for a vignette in the first condition, there was a biological description for the vignette in the second condition. Trials and runs were randomized for each participant across both tasks. All experimental procedures were presented using E-Prime software (Psychology Software Tools Inc., Pittsburgh, PA, USA).

After scanning was completed, participants answered individual difference questionnaires (demographic information, need for cognition scale, reading the mind in the eyes, social dominance orientation,

disgust sensitivity, free will). Participants were paid $30 for completing the study.

fMRI data collection and analysis strategy

All fMRI data were acquired at the Duke University Brain Imaging and Analysis Center using a 3T GE Signa Excite MR scanner (General Electric, Waukesha, WI, USA). An initial T1-weighted whole-brain structural image was acquired at a spatial resolution of 1 × 1 × 1 mm. Nine EPI runs consisting of either 254 (legal decision-making) or 212 (logic localizer) volumes were acquired using an echo-planar imaging pulse sequence. Each volume consisted of 39 interleaved axial slices oriented parallel to the anterior commissure-posterior commissure (AC-PC) line [TR = 2000 ms; TE = 25 ms; matrix = 256 × 256; field of view = 192 mm; voxel size = 3 × 3 × 3 mm].

Functional images were preprocessed using Brain Voyager QX (http://brainvoyager.com/). The initial two volumes from each run were discarded. Preprocessing included slice scan time correction using cubic spline interpolation, 3D motion correction with trilinear interpolation, and high- and low-pass temporal filtering. Functional images were normalized using the Talairach atlas (Talairach & Tournoux, 1988) and smoothed using a Gaussian kernel of full width at half maximum (FWHM) 4 mm.

Our ROIs were functionally defined using the logic localizer task based on the contrast valid + invalid > baseline (fixation). This allowed us to isolate brain regions engaged during deductive reasoning[1]. We extracted betas in each region during the responsibility and punishment screens before subjecting them to a 2 × 2 repeated measures ANOVA. This allowed us to test whether our main effects interact to influence responses in brain regions implicated in logical reasoning during responsibility judgments and third-party punishment decisions. We also performed whole-brain contrasts for each main effect (see Table 1). Finally, we regressed responsibility judgments and punishment decisions onto blood oxygen level-dependent (BOLD) activity and report regions that correlate with judgment severity (see Table 2).

[1] Given that the contrast used was valid + invalid > baseline (fixation), we found regions that were less active during the task, including the superior frontal gyrus, parahippocampal gyrus, and medial frontal gyrus. These regions have previously been implicated in default mode activity (see Buckner, Andrews-Hanna, & Schacter, 2008), and were not included in our statistical analyses.

RESULTS AND DISCUSSION

Behavioral results

Personality descriptions significantly affected responsibility judgments, $F(1, 19) = 14.01$, $p = .001$, partial $\eta^2 = .424$, reducing responsibility ratings when described in biological language (Figure 2(a)). This suggests that responsibility judgments during legal decision-making are biased by personality language. Additionally, personality descriptions significantly affected punishment decisions, $F(1, 19) = 6.92$, $p = .016$, partial $\eta^2 = .27$, such that there was more punishment when vignettes were accompanied by descriptions of personality using trait language (Figure 2(b)). This suggests that biological personality descriptions mitigated punishment.

We found a significant disgust main effect during punishment decisions, $F(1, 19) = 20.18$, $p < .001$, partial $\eta^2 = .52$, such that there were harsher sentences when crimes were strong in disgust (Figure 2(b)). Disgust did not affect responsibility judgments.

We next compare punishment ratings to the US Guidelines as an objective measure of whether current decisions match modern legal standards. Behavioral results demonstrate that crimes in the weak disgust category are punished significantly less harshly than the guidelines recommend, $t(19) = -2.31$, $p = .033$, while punishment decisions for the crimes with strong disgust matched legal recommendations, $t(19) = .21$, $p = .840$ (see Figure 2(b)). These results indicate that decision-makers assign punishment that more closely matches current state and federal legal standards if the crime elicits strong disgust. Biological and trait personality descriptions did not have an effect on punishment decisions compared to the legal guidelines.

Brain imaging results: ROI analysis

The logical reasoning ROI analysis revealed greater activity in bilateral dorsolateral prefrontal cortex (DLPFC; $x = 49$, $y = 21$, $z = 32$; $t = 9.97$, $p = 2.881E{-}11$, partial $\eta^2 = .84$) extending into middle frontal gyrus, bilateral precuneus extending to the inferior parietal lobule (IPL; $x = -26$, $y = -72$, $z = 41$ $t = 19.43$, $p = 1.498E{-}12$, partial $\eta^2 = .95$), and left middle temporal gyrus (MTG; $x = -59$, $y = -39$, $z = 2$; $t = 9.82$, $p = 3.549E{-}09$, partial $\eta^2 = .84$), consistent with previous literature (Monti et al., 2009). Our statistical analyses of these ROIs demonstrate that brain regions active during logical

TABLE 1

Brain regions derived from main effect legal decision-making paradigm contrasts. Data were corrected for multiple comparisons using a false discovery rate listed in table. *X*, *Y*, *Z* coordinates represent peak voxel activation

	BA	*Hemisphere*	*X*	*Y*	*Z*	*t*	*p*	*Effect size*
Strong disgust > weak disgust (vignette)								
$p = .05$ c(V) = In(V) + E								
Inferior frontal gyrus	44	R	52	15	14	9.1	2.37E–08	0.81
Caudate		L	−11	6	11	7.34	5.91E–07	0.74
Lentiform nucleus, lateral globus pallidus		L	−20	−6	−7	7.51	4.25E–07	0.75
Insula	13	L	−38	18	8	7.78	2.53E–07	0.76
Trait > biology (vignette)								
No significant regions								
Strong disgust > weak disgust (responsibility)								
$p = .005$ c(V) = In(V) + E								
Cerebellum		L	−41	−57	−31	−10.4	2.79E–09	0.85
Trait > biology (responsibility)								
$p = .01$ c(V) = In(V) + E								
Cerebellum		R	34	−75	−19	8.62	5.47E–08	0.8
Lingual gyrus	18	R	25	−96	−4	7.71	2.86E–07	0.76
Posterior cingulate	30	R	7	−54	8	7.86	2.18E–07	0.76
Cerebellum		L	−29	−81	−19	9.63	9.66E–09	0.83
Parahippocampal gyrus		L	−26	−15	−10	8.3	9.68E–08	0.78
Strong disgust > weak disgust (punishment)								
$p = .005$ c(V) = In(V) + E								
Cerebellum		R	52	−66	−22	8.68	4.86E–08	0.8
Cuneus	19	R	4	−93	38	12.18	2.20E–10	0.89
Cerebellum		R	16	−57	−13	10.81	1.48E–09	0.86
Superior frontal gyrus	10	R	25	60	11	7.72	2.83E–07	0.76
Cingulate gyrus	32	R	4	24	38	10.27	3.44E–09	0.85
Cingulate gyrus	31	R	1	−30	32	7.16	8.38E–07	0.73
Superior parietal lobule	7	L	−35	−57	50	8.33	9.16E–08	0.79
Caudate		L	−20	−33	23	11.01	1.10E–09	0.86
Cingulate gyrus	24	L	−17	12	26	8.2	1.15E–07	0.78
Superior parietal lobule	7	L	−23	−72	47	7.12	9.01E–07	0.73
Superior frontal gyrus	10	L	−20	63	8	8.25	1.05E–07	0.78
Trait > biology (punishment)								
No significant regions								

reasoning differentiate our experimental conditions consistent with the behavioral pattern. Specifically, the left DLPFC shows a personality description main effect during responsibility judgments, $F(1, 19) = 8.17$, $p = .01$, partial $\eta^2 = .30$, such that there is less activity when biological language is present (see Figure 3(a)). The difference is especially apparent in weak disgust crimes, $t(19) = –3.17$, $p = .005$. Activity in the left precuneus is sensitive to disgust during punishment decisions, $F(1, 19) = 8.63$, $p = .008$, partial $\eta^2 = .31$, such that strong disgust crimes activate this brain region more than weak disgust crimes (see Figure 3(b)). Furthermore, this main effect is qualified by a significant simple effect, such that the difference is driven by personality description; biological language reduces activity in this region for weak disgust crimes, $t(19) = –2.50$, $p = .02$.

A full list of the active regions is found in Table 3. We averaged across activity in each of these regions to create a measure of brain response in regions active during logical reasoning. This contrast includes areas such as the visual regions in the brain that may not be typically associated with legal decision-making. However, this analysis structure should make the results more conservative, allowing us to interrogate a logical reasoning brain network, as opposed to relying on reverse inferences to interpret activation in a single brain region.

Consistent with our hypotheses, we find the main effect of disgust ($F(1, 19) = 21.40$, $p = .001$, partial $\eta^2 = .53$) during responsibility judgments, such that crimes with a strong disgust component ($M = .15$, $SD = .43$; see Figure 4(a)) activate these regions less than weak disgust crimes ($M = .46$, $SD = .42$), which is compatible with a dehumanized response in the brain. We also find a main effect of personality descriptions during responsibility judgments ($F(1, 19) = 14.54$, $p = .001$, partial $\eta^2 = .43$), such that crimes with a trait personality description ($M = .39$, $SD = .43$) activate these regions more than crimes with a biological personality description ($M = .21$, $SD = .43$).

TABLE 2

Brain regions that correlate with judgment severity. Data were corrected for multiple comparisons using a false discovery rate listed in table. *X*, *Y*, *Z* coordinates represent peak voxel activation

	BA	*Hemisphere*	*X*	*Y*	*Z*	*t*	*p*	*Effect size*
Responsibility								
$p = .005$ c(V) = In(V) + E								
Inferior frontal gyrus	45	R	58	24	8	−7.85	2.20E–07	0.76
Cerebellum		R	25	−63	−13	11.53	5.10E–10	0.87
Inferior frontal gyrus	47	R	28	27	−16	−9.36	1.52E–08	0.82
Postcentral gyrus	1	L	−44	−30	59	16.49	1.03E–12	0.93
Anterior cingulate	32	L	−2	45	−1	−7.55	3.91E–07	0.75
Anterior cingulate	25	L	−2	6	−7	−6.95	1.00E–06	0.72
Cuneus	19	L	−11	−75	32	8.25	1.06E–07	0.78
Thalamus		L	−14	−27	2	8.08	1.46E–07	0.77
Cerebellum		L	−26	−72	−13	9.68	8.86E–09	0.83
Middle frontal gyrus	11	L	−29	33	−19	−8.38	8.33E–08	0.79
Punishment								
$p = .001$ c(V) = In(V) + E								
Parahippocampal gyrus, amygdala		R	25	−9	−16	−11.49	5.41E–10	0.87
Inferior parietal lobule	40	R	43	−48	47	9.62	9.79E–09	0.83
Insula	13	R	34	18	14	8.03	1.58E–07	0.77
Middle frontal gyrus	9	R	40	27	32	5.98	9.00E–06	0.65
Cerebellum		R	22	−51	−28	7.66	3.17E–07	0.76
Middle occipital gyrus	18	R	25	−90	11	6.2	6.00E–06	0.67
Frontal lobe, sub-gyral	6	R	25	−3	53	6.39	4.00E–06	0.68
Superior frontal gyrus	8	L	−8	42	44	−11.46	5.58E–10	0.87
Cerebellum		R	13	−33	−22	−6.48	3.00E–06	0.69
Inferior parietal lobule	40	L	−44	−36	44	13.21	5.02E–11	0.9
Parahippocampal gyrus, amygdala		L	−26	−9	−16	−15.44	3.29E–12	0.93
Cuneus	18	L	−2	−90	14	−10.84	1.41E–09	0.86
Paracentral lobule	5	R	1	−36	56	−8.01	1.64E–07	0.77
Middle frontal gyrus	6	L	−29	12	47	−7.56	3.86E–07	0.75
Insula	13	L	−32	12	11	9.83	6.94E–09	0.84
Precentral gyrus	6	L	−47	−3	53	−6.83	2.00E–06	0.71

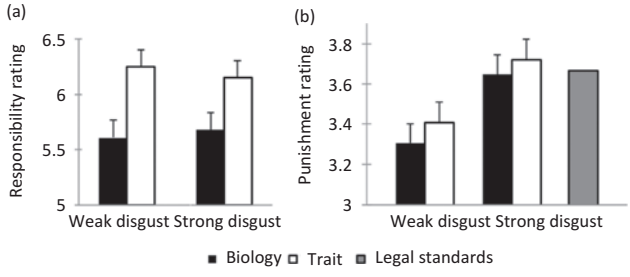

Figure 2. Behavioral responsibility (a) and punishment (b) ratings. Error bars represent standard error of the mean.

Both main effects are qualified by a significant interaction ($F(1, 19) = 5.33$, $p = .032$, partial $\eta^2 = .22$). We followed up this significant interaction with a series of simple effect tests. We first compared personality descriptions within each level of disgust. We found that weak disgust crimes with a trait personality description recruit significantly more brain activity than weak disgust crimes with a biological personality description ($t(19) = –4.04$, $p = .001$), suggesting that weak disgust crimes are susceptible to bias by biological personality descriptions in the logical reasoning network. We found no such difference within strong disgust crimes ($t(19) = –0.84$, $p = .413$), suggesting that no such bias exists when the crime is strong in disgust. We then compared levels of disgust within each personality description. There was a significant difference between the strong and weak disgust crimes with a biological personality description ($t(19) = 2.77$, $p = .012$), such that there was more activity for weak than strong disgust crimes with biological personality descriptions. Similarly, there was a significant difference between the strong and weak disgust crimes with trait personality descriptions ($t(19) = 4.35$, $p = .001$),

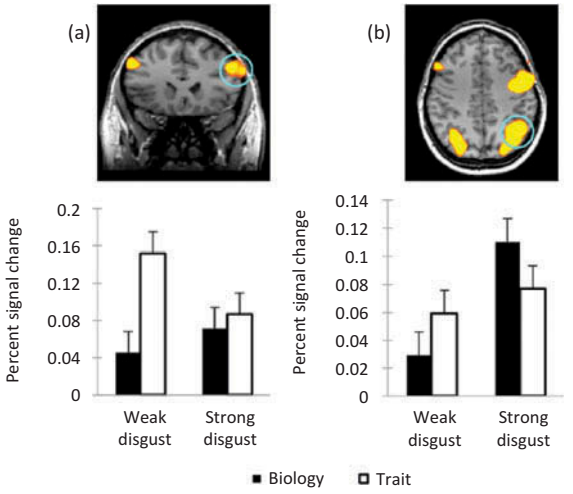

Figure 3. ROIs from logical reasoning task, circles indicate corresponding region. (a) Brain activity during responsibility in left DLPFC (z = 21), percent signal change graph below. (b) Brain activity during punishment in left precuneus (z = 40), percent signal change graph below.

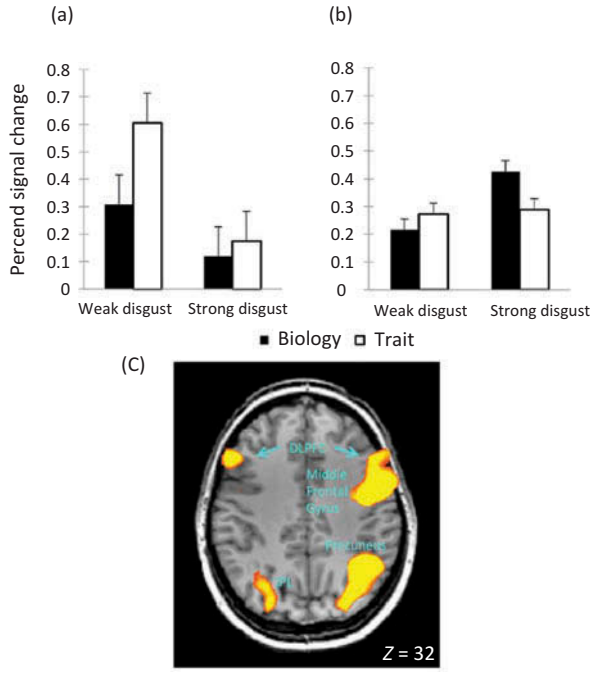

Figure 4. Brain activity across all regions identified during the logic localizer task. (a) Activation during responsibility judgments. (b) Activation during punishment decisions. Error bars represent standard error of the mean. (c) Regions active during the logic localizer task. A list of all active regions is shown in Table 1. Data were corrected for multiple comparisons using a false discovery rate of p =.001, c(V) = ln(V) + e.

such that there was more activity to crimes in the weak disgust condition when there was a trait personality description. The latter two simple effects suggest that weak disgust crimes reduce engagement of the logical reasoning brain network for both biological and personality descriptions.

During punishment decisions, there was a marginally significant effect of disgust (F(1, 19) = 3.96, p =.061, partial η^2 = .17), such that there was more activity in response to strong than weak disgust crimes (Figure 4(b)). Given our hypothesis, we chose to conduct follow-up simple effect tests between levels of disgust within personality description. Consistent with our hypotheses, there was a significant difference between crimes in the strong and weak disgust conditions when there was a biological personality description (t(19) = –3.247, p = .004), such that there was more activity in the network for strong than weak disgust conditions that had a biological personality description. This suggests that biological personality descriptions only reduce activity in the logical reasoning network during punishment decisions when crimes were weak, not strong in disgust. We did not find a similar difference during trait personality descriptions (t(19) = –0.16, p = .879). Finally, we did not find a

TABLE 3

Brain regions derived from the logic localizer. Data were corrected for multiple comparisons using a false discovery rate of p = .001, c(V) = ln(V) + E. X, Y, Z coordinates represent peak voxel activation

Region	*BA*	*Hemisphere*	*X*	*Y*	*Z*	*t*	*p*	*Effect size*
Middle frontal gyrus/dorsolateral prefrontal cortex	9	R	49	21	32	9.97	2.88E–08	0.84
Precuneus	7	R	25	−72	41	15.05	7.30E–11	0.92
Fusiform gyrus	18	L	–23	−90	−19	16.06	2.73E–11	0.93
Precentral gyrus	6	R	28	−9	50	10.68	1.09E–08	0.86
Thalamus		R	22	−27	−1	9.71	4.16E–08	0.83
Medial frontal gyrus	6	L	–8	0	53	12.51	1.13E–09	0.89
Precuneus/inferior parietal lobule	19	L	–26	−72	41	19.43	1.50E–12	0.95
Lentiform nucleus		L	–20	−6	17	7.71	8.87E–07	0.76
Lateral geniculum body		L	–23	−27	−4	9.01	1.15E–07	0.81
Precentral gyrus	6	L	–38	−6	38	17.15	1.01E–11	0.94
Middle temporal gyrus	21	L	–59	−39	2	9.82	3.55E–08	0.84

significant main effect for personality descriptions in the punishment decision dependent variable, ($F(1, 19) = 0.86$, $p = .364$, partial $\eta^2 = .04$).

Brain imaging results: Whole brain contrasts

We conducted whole brain contrast analyses derived from the main effects of the legal decision-making task to identify regions associated with legal decision-making (see Table 1 for peak voxel Talairach coordinates and effect size). We compared brain activity associated with the vignette screen during the legal decision-making task across strong versus weak disgust, which revealed more activation during strong disgust crimes in the inferior frontal gyrus (BA 44; $t(19) = 9.1$, $p = 2.370E{-}08$) and the insula (BA 13; $t(19) = 7.78$, $p = 2.528E{-}07$). During the responsibility screen, brain regions including the lingual gyrus (BA 18; $t(19) = 7.71$, $p = 2.860E{-}07$) and posterior cingulate cortex (BA 30; $t(19) = 7.86$, $p = 2.180E{-}07$) were more active for trait personality descriptions than for biological personality descriptions. Interestingly, there were fewer regions that responded during the responsibility screen to the disgust manipulation, suggesting that personality descriptions affect responsibility judgments more than disgust. Moreover, during the punishment screens, there were no significant regions that differentially responded to the trait manipulation, while regions like the superior frontal gyrus (BA 10; $t(19) = 7.72$, $p = 2.830E{-}07$) and superior parietal lobule (BA 7; $t(19) = 8.33$, $p = 9.160E{-}08$) were more active when there was strong disgust versus weak disgust, further dissociating the differences between responsibility judgments and punishment decisions.

A whole-brain contrast for responsibility judgments versus punishment decisions revealed greater activity in frontal and temporal regions, such as the superior frontal gyrus (BA 8; $t(19) = 7.46$, $p = 4.67E{-}07$), inferior frontal gyrus (BA 45; $t(19) = 11.97$, $p = 2.70E{-}10$), and the middle temporal gyrus (BA 21; $t(19) = 7.55$, $p = 3.88E{-}07$) during responsibility judgments. During punishment decisions, there was greater activity in the parietal and temporal regions, including the inferior parietal lobule (BA 40; $t(19) = -7.52$, $p = 4.16E{-}07$), precuneus (BA 39; $t(19) = -7.79$, $p = 2.48E{-}07$), and inferior temporal gyrus (BA 37; $t(19) = -9.62$, $p = 9.85E{-}09$). These differentiations suggest that responsibility judgments and punishment decisions are driven by separable mechanisms in the brain (see Table 4 for a full list of regions).

Brain imaging results: Brain correlates of behavior

We also regressed responsibility judgments and punishment decisions onto BOLD activity to investigate what regions correlate with judgment severity (Table 2). We found evidence to support the notion that responsibility judgments and third-party punishment decisions are different cognitive systems, relying on different brain regions. The inferior frontal gyrus (BA 45; $t(19) = -7.85$, $p = 2.200E{-}07$), anterior cingulate cortex (BA 32, $t(19) = -7.55$, $p = 3.910E{-}07$; BA 25, $t(19) = -6.95$, $p = 1.000E{-}06$), and middle frontal gyrus (BA 11; $t(19) = -8.38$, $p = 8.330E{-}08$) were the regions associated with responsibility judgments. All of these regions are largely associated with cognitive tasks. Punishment decisions were associated with the amygdala ($t(19) = -11.49$, $p = 5.410E{-}10$), inferior parietal lobule (BA

TABLE 4

Brain regions derived from legal decision-making paradigm contrast. Data were corrected for multiple comparisons using a false discovery rate of $p = .005$ c(V) = ln(V) + E. *X*, *Y*, *Z* coordinates represent peak voxel activation

	BA	*Hemisphere*	*X*	*Y*	*Z*	*t*	*p*
Responsibility							
Paracentral lobule	5	L	−11	−36	53	8.29	9.86E–08
Superior frontal gyrus	8	L	−20	45	41	7.46	4.67E–07
Superior frontal gyrus	6	L	−14	30	59	7.29	6.53E–07
Inferior frontal gyrus	45	L	−50	21	5	11.97	2.70E–10
Middle temporal gyrus	21	L	−50	0	−22	16.75	7.82E–13
Middle temporal gyrus	21	R	46	6	−22	7.55	3.88E–07
Parahippocampal gyrus		R	25	−15	−13	7.39	5.30E–07
Posterior lobe, declive		R	13	−69	−13	14.44	1.07E–11
Punishment							
Inferior temporal gyrus	37	R	55	−45	−16	−9.62	9.85E–09
Inferior parietal lobule	40	R	46	−39	50	−7.52	4.16E–07
Precuneus	39	R	31	−66	32	−7.79	2.48E–07

40; $t(19) = 9.62$, $p = 9.790E{-}09$), middle frontal gyrus (BA 9; $t(19) = 5.98$, $p = 9.000E{-}06$), and the insula (BA 13; $t(19) = 8.03$, $p = 1.580E{-}07$). These regions are associated with affective processing, among other processes. While we must remain cautious when interpreting these preliminary whole-brain analyses, the results suggest that personality descriptions may be affecting responsibility judgments more than punishment decisions, and that disgust may exert an influence over punishment decisions; a dissociation between cognition and affect in legal decision-making.

GENERAL CONCLUSION

The legal system presents an interesting arena to explore the interplay between emotion and reason. Courts of law require decision-makers to use logical reasoning about mental states regarding morally charged situations. However, it appears that mental state inferences may facilitate responsibility judgments, while emotional responses may negatively affect responsibility judgments while facilitating punishment decisions. In fact, two pervasive factors that affect legal decision-making—the disgusting nature of the crime and descriptions of the perpetrator's personality—influence participants' legal logical reasoning. Participants make estimates of punishment severity that match current legal punishment standards *only when* crimes elicit strong disgust responses, suggesting that legal standards may have evolved to inherently punish those who committed particularly brutal acts. Crimes prosecuted in early legal systems such as murder, sex offenses, and witchcraft were predominantly morally disgusting (Stearns, 1936), and may have set the standards of legal decision-making practices today. Additionally, participants' logical reasoning during responsibility judgments is not affected by biological personality descriptions during these strong disgust crimes, but we find differentiations based on personality descriptions during weak disgust crimes, again emphasizing the interplay between an enhancement and inhibition of logical legal decision-making depending on the psychological mechanism. Together, these results suggest that psychological factors relevant to dehumanization—disgust and a lack of unique, individuating mental states—operate in courts of law due to the nature of the social environment.

Although biological descriptions sometimes do provide exculpatory contexts in the courtroom, our design ensured that neither the trait nor the biological personality sentences were causally related to the crime. Rather, our participants fell prey to the alluring alternative biological explanation of behavior, despite the fact that there was no real causal link between the trait sentence and the behavior (see Weisberg, Keil, Goodstein, Rawson, & Gray, 2008). This is a real problem in courts today—the introduction of scientific evidence may not pass Frye or Daubert standards (or commercialized research is used to claim the evidence is valid, while the general field of MRI researchers may disagree) yet being exposed to scientific evidence changes the way people process mental state information. Even if the apparent causal locus of the agent's behavior is shifted, a third-party decision-maker should not have engaged in that logic; the biological information is not predictive of behavior, while most inferred traits do predict behavior. However, our study was designed to limit the predictive inferences between the trait and biological personality descriptions by ensuring that the information was included as an extraneous variable.

Both disgust and personality descriptions directly affect logical processing mechanisms in the brain. Here, we use a social neuroscience approach as a proof of concept. This provides a well-established imaging-dependent variable to test a social psychological question. This social neuroscience approach allows us to avoid the pitfalls of reverse inferences (Poldrack, 2006) and brain mapping (Caccioppo, et al., 2003). Our ROI results demonstrate a more nuanced pattern of activation in logical reasoning brain regions than we observed in legal decision-making behavior alone. Other mechanisms, such as emotion processing, social cognition, or decision-making brain processes, may also impact the behavioral results. Therefore, we restrict our inferences to logical reasoning mechanisms. Future studies should explore the impact of these manipulations on other psychologically relevant mechanisms and their corresponding brain networks, including emotion, morality, empathy, and social cognition networks.

It is important to note that the regions identified by our ROI analysis are not restricted to deductive inference processes; the precuneus, MTG, and DLPFC have been implicated in a host of tasks, including other third-party punishment tasks (Buckholtz et al., 2008), moral judgment (Greene, Nystrom, Engell, Darley, & Cohen, 2004), and social cognition (Wolf, Dziobek, & Heekeren, 2010). Our results depict greater activity in these brain regions for trait accounts of personality than for biological accounts of personality. Furthermore, our whole-brain analyses begin to demonstrate the subtle differences between responsibility judgments and punishment decisions, suggesting that regions involved in responsibility judgments are more sensitive to the personality descriptions,

while regions engaged during punishment decisions may be more sensitive to disgust. Future studies should discern whether negative affect and high arousal levels generally, or strong disgust specifically, affect legal decisions.

One possible interpretation of our pattern of brain data results stems from social psychological evidence suggesting that trait inferences are an automatic, inherent response when perceiving other people (see Asch, 1946; Higgins, Rholes, & Jones, 1977; Kelley, 1950). Perhaps the trait inferences in our results serve as a baseline, reflecting the relative activation of these brain regions during actual legal decision-making. Because trait inferences are so easy to make, our participants may have made more direct associations between the trait descriptions and the defendant's behavior, leading to negative character evaluations that were not as apparent when there was a biological personality description. Furthermore, weak disgust increases activity to trait inferences in these brain regions during responsibility judgments. This suggests trait inferences may buffer logical reasoning during punishment decisions, but logical reasoning during responsibility judgments remains susceptible to differing personality descriptions. This may prove useful to legal decision-makers on both sides of the adversarial divide.

The roots of our legal system are informed by the intellectual prowess of seventeenth-century legal scholars that were actively attempting to move toward a more scientifically systematic legal system that employed strict rational and mathematical principles in its constructs (Hoeflich, 1986; Kocher, 1957). It is not surprising that today, given the complexities of criminal cases and the advanced understanding of the biology of social behavior, responsibility judgments and punishment decisions are becoming more controversial. For example, although we place emphasis on the perpetrator's mental states and personality during legal decision-making, the introduction of scientific explanations for personality in the courtroom presents a new wrinkle not considered when these legal systems evolved, and presents new sources of bias that affect legal decision makers. Biological personality descriptions dehumanize the person, reducing them to a mechanistic, biological organism and not a human being whose mental states are highly unique and salient during responsibility judgments, while weak disgust crimes may not enable a vigilant decision-making system that relies on logical reasoning during punishment decisions.

The pattern of activity in brain areas associated with logical reasoning may thus reflect inherent biases during legal decision-making. In essence, current legal decision-making processes may unknowingly guide decision-makers to reason differently about others due to emotional and social cognitive factors that affect brain mechanisms underlying logical reasoning. These results extend the psychological research on the effects of emotions and reasoning in decision-making to a legal context. Moreover, they demonstrate that a behaviorally inspired social neuroscience approach (Todorov et al., 2006) can elucidate mechanisms for social behavior relevant to the real world.

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