Coping with Chronic Environmental Contamination:

Exploring the Role of Social Capital

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Harrison J. Schmitt[1], Daniel Sullivan[1], Alexis N. Goad[1], and Roman Palitsky[2]

[1] Department of Psychology, University of Arizona

[2] Department of Psychiatry and Human Behavior, Brown University

Author Note

Harrison Schmitt ⒾⒹ https://orcid.org/0000-0002-1630-3976

Correspondence concerning this article should be addressed to Harrison J. Schmitt, 1503 E. University Blvd., Tucson, AZ 85721. Email: hschmitt@arizona.edu

Abstract

The experience of chronic environmental contamination (CEC) is an increasingly prevalent environmental hazard faced by communities around the world. Evidence suggests that this experience can be psychologically stressful. However, CEC is an of often-overlooked environmental justice issue and collective action problem in the psychology literature. We explore the role of social capital as a buffer for the negative impacts of CEC using geographical (Study 1), qualitative (Study 2), and experimental (Study 3) methods. Study 1 shows that US county-level social capital buffers the relationship between air pollution and mental distress. Study 2 presents a qualitative analysis of 13 interviews conducted with people impacted by CEC in Tucson, AZ, focusing on sources of stress, coping mechanisms, and the role of social capital the CEC experience. Study 3 presents an experiment conducted with Tucson residents using a 2(CEC threat) $\times$ 2(perceptions of social capital induction) design to investigate the role of social capital in efficacy and defensive denial responses to CEC threat. Though the onset of CEC can damage networks of social capital (Study 2), increasing community perceptions of social capital may be an important avenue for future research (Study 3). We discuss the importance of mixed-methods approaches, as well as the importance of integrating theorizing on social capital into the psychology literature to address invisible and chronic stressors like CEC.

Highlights

- Chronic environmental exposures are understudied environmental justice issues
- Social capital buffers the negative mental health impacts of these issues
- Geographical, qualitative, and experimental evidence converge to show the importance of social capital
- Mixed methods are well-suited to address these environmental justice issues

Coping with Chronic Environmental Contamination: Exploring the Role of Social Capital

As climate change makes natural disasters more frequent and more intense, and as human-made contaminants are better detected with technological advances, people will increasingly have intimate experiences with environmental hazards (IPCC, 2014; Noguera-Oviedo & Aga, 2016). Given the projected magnitude of these issues, it is important for psychologists to investigate the ramifications of exposure to environmental health hazards, especially as they pertain to mental health, coping, and collective action. Some recent work has begun to explicate the psychological ramifications of the threat of climate change, environmental contamination, and natural disasters (Bonanno et al., 2010; Fritsche et al., 2012; Sullivan & Young, 2020). This literature has revealed that environmental hazards have a multitude of psychosocial consequences for the individuals, communities, and institutions they affect.

In the present paper, we contribute to the psychological literature on coping with environmental issues by addressing two important phenomena that have received less prior attention. First, literature in psychology on collective action and coping with environmental issues largely ignores the role of *social capital*, or the economic, psychological, and other resources available to individuals as a result of social networks which can be leveraged for collective action (Cline et al., 2010, 2014; Putnam, 2000). Second, with important exceptions (e.g., Bonam et al., 2017; Perez et al., 2021), there has been little work in quantitative empirical psychology on environmental injustice. Environmental hazards impact economically disadvantaged and racial/ethnic minority communities with much greater frequency (Kramar et al., 2018; Vyner, 1988). Environmental injustice refers not only to disproportionate siting of and exposure to environmental hazards but to different experiences of and responses to exposure in disadvantaged communities (Mohai & Saha, 2015; Seamon, 2013). One increasingly common

form of environmental injustice which will be the focus of the present paper is the experience of chronic environmental contamination (CEC), or "living in an area where hazardous substances are known or perceived to be present in air, water, or soil at elevated levels for a prolonged and unknown period of time" (Schmitt et al., 2021, p. 1).

Drawing on work in environmental and ecological psychology advocating for mixed-methods (Georgiou & Carspecken, 2002; Winkel et al., 2009), we present complementary geographical, qualitative, and experimental investigations of the role of social capital in coping with and responding to CEC. We present a county-level analysis of the associations between air pollution, mental health, and social capital (Study 1). We then present a thematic analysis of interviews with community members in Tucson, AZ, USA affected by contamination, focusing on stress experiences, coping mechanisms, and (broken) networks of social capital (Study 2). We then present an experimental community study of the role of social capital in responses to the threat of contamination (Study 3). This mixed-methods approach provides a number of unique opportunities for the psychological study of environmental issues, and is well-suited to examining an issue that has received little attention in environmental psychology to date, namely, the role of social capital in environmental justice.

The Psychosocial Experience of Chronic Environmental Contamination

Michael Edelstein calls CEC the "plague of our time," as "one in six… Americans live within four miles of a chemical dump or suspected other hazardous waste site" (Edelstein, 2018, p. 4). Such chemicals, when handled poorly or released as a result of a natural or human-made disaster, can lead to chronic air, water, and soil contamination with negative health impacts. Infamous cases of CEC have dotted environmental discourse over the past several decades: from waste dumping in Love Canal in the 1970s (Gibbs, 2002), to the highly-publicized lead

contamination in the water of Flint, MI, USA in 2014 (Cuthbertson et al., 2016). However, CEC represents an environmental hazard that Nixon (2011) calls "slow violence," or one whose impacts are dispersed across a long period of time, resulting in a sort of invisibility that often precludes CEC from the attention of journalists and scholars. Much of the literature in psychology on environmental catastrophes focuses on the acute and traumatic immediate fallout from natural and human-made disasters (Bonanno et al., 2010; Norris, 2006), or on hypothetical and distant threats like climate change (Jugert et al., 2016). The present paper seeks to engage with the mental health and coping implications of slower, invisible environmental hazards.

Living through CEC can cause considerable stress for impacted communities (Downey & Van Willigen, 2005; Edelstein, 2018). CEC is a unique form of environmental hazard in its singular ambiguity and uncertainty (Vyner, 1988), and is associated with such negative psychological health outcomes as post-traumatic stress, depression, and anxiety (Schmitt et al., 2021). There are both material and social dimensions of CEC impact (Kroll-Smith et al., 1991). The material dimension of impact concerns the disruption of the physical environment and the physical embodiment of the contamination through real or perceived health impacts. The social dimension concerns the interpretations of the material dimension adopted by the people involved and the interactions between community members and other stakeholders, which often result in intra-community conflict and conflict between the community and other stakeholders (Cline et al., 2014). Past literature suggests that the (perceived) presence of physical health impacts from CEC (i.e., material impacts; Ginsberg et al., 2012), and the perception that one's concerns about CEC are being delegitimized by government, public health, corporate, and other officials (i.e., social impacts; Calloway et al., 2020), exacerbate stress experiences for impacted communities (for further discussion, see Sullivan et al., 2021).

Edelstein (2018) suggests the importance of a third, historical dimension of impact which includes the historical events and (decades-long) social processes pertinent to the community's understanding of the exposure, amounting to the "cumulative injuries" (p. 26) inflicted on the community. The discovery of the existence of CEC in one's community can bring about a complete upheaval of basic and hidden assumptions about the world (Janoff-Bulman, 2010), including beliefs in the naïve security of the environment and the home, and trust in governmental and public health institutions (Edelstein, 2018). Along with this upheaval of belief systems, the typical historical trajectory of CEC is cyclical: the stress of the initial discovery of contamination is repeatedly revisited over time via such social processes as the designation of the boundaries of the contaminated site, lawsuits that may result from the contamination, the discovery of new contaminants, or the delegitimization of concerns by powerful institutions during interactions at public health meetings or healthcare visits (Couch & Coles, 2011).

Coping with Chronic Environmental Contamination through Collective Action

While addressing the material dimension of CEC (i.e., mitigating exposures to contamination, addressing health concerns) may be outside of the purview of most psychologists, intervening on the social and disrupting the typical trajectory of the historical dimension of impact are worthwhile pursuits for the field (Schmitt & Sullivan, 2022). One way to attain these goals is to foster collective efficacy in order to increase problem-focused (collective) coping. Problem-focused coping strategies include various proactive and preventive collective actions taken to mitigate the impacts of CEC, such as protesting, advocacy, and information seeking or sharing (Baum et al., 1983; Sullivan & Young, 2020). Emotion-focused coping strategies in this context are individual or collective actions that work to manage emotional distress, such as

getting validation from other impacted family or community members (Hallman & Wandersman, 1992).

Problem-focused coping through collective action is important for responding to environmental issues, which involve infrastructural, scientific, technological, and political aspects that cannot be adequately addressed at the individual level (Ostrom, 1990). Further, being involved in collective actions can have secondary psychological benefits, as evidenced by the work of Baum and colleagues (1983) showing that activism following the Three Mile Island nuclear accident decreased stress responses. Recent literature on coping in the face of environmental issues has revealed that perceptions of collective efficacy are consistently associated with collective action (Bamberg et al., 2015), and that experimental manipulations of collective efficacy can increase problem-focused collective action intentions (e.g., Jugert et al., 2016; van Zomeren et al., 2010).

In the psychology literature, social identity models have been used to demonstrate the explanatory power of collective efficacy, group identification, perceived injustice, and norms in driving collective action in the context of environmental issues (Duncan, 2018; Fritsche et al., 2018). However, these models have not been applied to coping with the "slow violence" of CEC specifically. Additionally, these models do not sufficiently consider the role of social-structural affordances (e.g., income level; inter-community networks; institutional support) in coping, collective efficacy, and action. Researchers (e.g., Thomas et al., 2020) typically focus on variation in group identification and collective efficacy, rather than examining in-depth the social-structural affordances that may also vary among disadvantaged group members and which presumably influence these psychological variables. We propose that an important avenue for productive work in psychology entails a broadening of the scope of such studies by engaging

with structural and historical aspects of lived experiences with slow-scale environmental hazards. One way of achieving this is via a more sustained consideration of the role of social capital.

Considering Social Capital

Past literature suggests that social capital is an important factor that contributes to a community's capacity for coping and resilience in response to CEC (Couch & Coles, 2011; Hawkins & Maurer, 2010). Psychological investigations have been somewhat slow to incorporate social structural features broadly, and social capital specifically, into models of collective efficacy and action (van Zomeren, 2016). However, sociology (e.g., McAdam et al., 2001) and public health (e.g., Szreter & Woolcock, 2004) literatures of the past two decades have incorporated theorizing on social capital. For the present paper, we utilize the typology of social capital set forth by Aldrich and Meyer (2015) and Szreter and Woolcock (2004), wherein social capital is a multilevel phenomenon with horizontal and vertical elements (Poortinga, 2012). Horizontally, a community is characterized by "bonding" (i.e., close, intra-community networks of support) and "bridging" (i.e., inter-community networking across loosely connected groups) social capital. Vertically, a community is characterized by its "linking" social capital, or the extent to which its network overlaps with powerful institutions. When these forms of social capital are seen as an accessible means of pursuing social change, the result is a sense of collective efficacy (Couch & Coles, 2011).

Literature on recovery from environmental catastrophe suggests that social capital is a vital facet of community resilience, partially due to the role it plays in facilitating collective action (Adger, 2003; Nakagawa & Shaw, 2004). For instance, bonding and bridging social capital have predicted more effective recovery and coping with natural disasters and CEC (Edelstein, 2018; Hastrup et al., 2007; Hawkins & Maurer, 2010). Likewise, linking social

capital is an important structural factor that affects community resilience (Murphy, 2007; Nakagawa & Shaw, 2004). Each type of social capital has unique benefits for a community recovering from environmental catastrophe (Aldrich & Meyer, 2015). Bonding social capital can facilitate immediate aid and emotional recovery from a disaster via social support, while bridging social capital can increase the availability of diverse resources. Linking social capital can facilitate long-term adaptation to and recovery from environmental catastrophe by solidifying networks of institutional support (Edelstein, 2018; Hawkins & Maurer, 2010).

Social capital is influenced both by existing disadvantages in a given community (Manstead, 2018; Szreter & Woolcock, 2004), and by the onset of the CEC itself (Cline et al., 2010, 2014). Exposures to environmental contaminants are more likely to occur in low-income and minority communities (Kramar et al., 2018; Nixon, 2011), and such communities are more likely to experience worse psychological outcomes from CEC due to the compounding of economic and discriminatory stressors on the one hand, with the stressors of CEC on the other (Pearlin et al., 2005). It is especially important to consider how environmental injustice and linking social capital interrelate in this context. Because hazards such as CEC often must be addressed via political and institutional means, those impacted by CEC must work with governmental and scientific institutions to undertake effective collective action. But ironically, the experience of CEC tends to decrease community trust in such institutions (Sullivan et al., 2021), further diminishing linking social capital in communities impacted by environmental injustice.

Indeed, the deleterious influence of CEC on various forms of social capital may be accentuated or buffered by social (dis)advantage. A recent study (Sullivan & Young, 2020) of responses to a hypothetical contamination threat showed that more disadvantaged individuals

(indexed by inherited or relativity style of place attachment) tended to defensively deny the

threat or scapegoat institutions, whereas more advantaged individuals (indexed by discovered

style of place attachment) tended to trust and identify with institutions, resulting in a higher

propensity toward collective action. The tie between the relationship with institutions and social

action that was observed in this study also offers indirect support for the notion that (particularly

linking) social capital plays a role in promoting adaptive coping with CEC. We argue it is critical

to address the more distal construct of social capital alongside the more proximal factors

typically investigated by psychologists.

Overview of Current Studies

Based on this literature review, we broadly hypothesize the following for the present

paper: the threat of CEC will generally have a deleterious impact on stress and coping, but this

relationship will be moderated by social capital, such that in the presence of social capital,

deleterious effects of CEC will be diminished, or even reversed. We conducted three studies

concerning the role of social capital in coping with CEC. Study 1 assessed county-level

geographical trends in air pollution, mental health, and social capital as an initial exploration of

the potential buffering role of social capital in the association between environmental hazards

and psychological stress. Studies 2 and 3 centered around a specific contamination event in the

Southside of Tucson, AZ, USA in order to offer richly contextualized and applied evidence of

the role of social capital in responses to CEC. Study 2 entailed a qualitative analysis of 13

interviews with Tucson residents who had intimate experience with water contamination. Study

3 drew on findings from Study 2 and utilized a 2(CEC threat) $\times$ 2(perceptions of social capital

induction) experimental design with Tucson residents to test the role of social capital in buffering

maladaptive and promoting adaptive coping with the threat of CEC.

This approach draws on prior work in environmental and ecological psychology that advocates for the use of mixed-methods to assess both environmental and individual-psychological phenomena, as well as to model their complex interrelationship (Georgiou & Carspecken, 2002; Winkel et al., 2009). It allowed us to first explore the phenomena of interest at the structural level in a large-scale geographical analysis (Study 1), then augment these findings with a richly contextualized qualitative analysis at the individual level (Study 2), and finally leverage the knowledge gained from this qualitative investigation to generate applied experimental hypotheses and materials (Study 3; see Power et al., 2018). Studies 2 and 3 were reviewed and approved by the Institutional Review Board (IRB) at the University of Arizona.

STUDY 1

We analyzed US county-level data to broadly assess associations between chronic exposure to environmental hazards, stress, and social capital. We assessed county-level average daily concentration of $PM_{2.5}$ in the air (particulate matter less than 2.5 micrometers in diameter), various forms of social capital, and mental distress. Our sample included counties in all 50 states and Washington, D.C. ($n = 3,108$). A sensitivity power analysis conducted in G*Power (Faul et al., 2009) revealed that the full sample would be sufficient to detect a Cohen's d of .10 at 80% power for intended moderation analyses. For analyses that included all covariates ($n = 2,641$), a sensitivity power analysis revealed that this would be sufficient to detect a Cohen's d of .11.

Method

Average Daily $PM_{2.5}$ and Mental Distress. We utilized data on average daily $PM_{2.5}$ and mental distress from the County Health Rankings and Roadmaps (2020). The $PM_{2.5}$ measure assesses average daily density of fine particulate matter in micrograms per cubic meter ($\mu g/m^3$) in a given county's air. $PM_{2.5}$ is a good county-level indicator of chronic exposure to

environmental hazards for a number of reasons. First, $PM_{2.5}$ is hazardous to mental and physical

health (Feng et al., 2016; Sass et al., 2017), allowing us to assess potential buffering effects of

social capital. Second, $PM_{2.5}$ is sufficiently common and widespread across the US, allowing us

to assess its impact across a large sample of counties. Finally, $PM_{2.5}$ is a better county-level

indicator of an environmental hazards than water or soil contamination, which are often much

more localized hazards that cannot be adequately generalized to the somewhat crude

geographical level of the county. Our indicator of county-level mental distress was

operationalized as the percent of adults in a county who reported 14 or more days of the past

month when their mental health was "not good."

Social Capital. We utilized data from the Social Capital Project from the Joint Economic

Committee of the US Senate designed to track progress and propose policy related to social

capital (United States Senate Joint Economic Committee, 2018). All county-level social capital

indexes represent *z*-transformed averages of several indicators of social capital (as described

below). This means that each index has a mean of 0 and standard deviation of 1, where higher

values indicate higher levels of social capital. The range of the indexes was somewhat dispersed,

with the lowest county having a score of -4.3 and the highest having a score of 2.9 across all

indexes, suggesting considerable variability in county-level social capital.

We did not have a county-level measure for the close connections of bonding social

capital. As a proxy measure for the distant ties of bridging social capital, we utilize the

Community Health Subindex, which includes religious congregations and non-religious non-

profit organizations, and a variety of civic engagement metrics like the share of people who

attended political meetings or served on a committee. We utilized this operationalization of

bridging social capital because it includes interactions that span across groups of people with

potentially dissimilar social identities (Szreter & Woolcock, 2004). In the results presented

below, we refer to this index as "bridging social capital."

As a proxy measure for the vertical ties of linking social capital, we utilized the

Institutional Health Subindex, which includes voting rates, census response rates, and confidence

in various institutions (e.g., public schools, media, corporations). We utilized this

operationalization of linking social capital because it includes interactions and trust between

communities and powerful institutions. These proxy measures for bridging and linking social

capital are similar to past operationalizations (Kyne & Aldrich, 2020; Poortinga, 2012). In the

results presented below, we refer to this index as "linking social capital."

Method of Analysis

In order to observe the unique effects of $PM_{2.5}$ exposure and social capital on mental

distress, we controlled for standard regional sociodemographic variables. These included county-

level population density, unemployment rate, median household income, high school graduation

rate, percent of county residents living in rural areas, and percent of the population who was non-

white (County Health Rankings and Roadmaps, 2020; United States Senate Joint Economic

Committee, 2018). Controlling for regional control variables significantly reduced the sample

size due to missing data from many counties. However, none of the outcomes of interest were

substantively changed when controlling for covariates, and we present results with and without

covariates (See Tables 2-3). Because neighboring counties cannot necessarily be considered

independent observations, a fundamental assumption of linear regression may be violated when

conducting regression analyses on these geographical data. As such, we tested and accounted for

spatial autocorrelation of the residuals in the models presented below (See Table S1-S2 in

Supplemental Materials for spatial models).

Results

See Table 1 for means, standard deviations, and correlations. We ran two multiple linear regression models that tested for interactions between average daily $PM_{2.5}$ and various indices of social capital on mental distress. In the first focal analysis, we regressed mental distress onto $PM_{2.5}$, the index of bridging social capital, and the interaction between $PM_{2.5}$ and bridging social capital in the same model. We observed a significant interaction between $PM_{2.5}$ and bridging social capital (b = -.07, SE = .02, 95% CI[-.11, -.03], t(3103) = -3.57, p < .001, d = .13), which was substantively unchanged when including all covariates (See Table 2). In the second focal analysis, we regressed mental distress onto $PM_{2.5}$, the index of linking social capital, and the interaction between $PM_{2.5}$ and linking social capital in the same model. We again observed a significant interaction between $PM_{2.5}$ and linking social capital (b = -.11, SE = .02, 95% CI[-.15, -.08], t(3081) = -6.77, p < .001, d = .24), which was also substantively unchanged when including all covariates (see Table 3).

In each case, the effect of $PM_{2.5}$ on mental distress was weaker or non-significant at higher levels of bridging and linking social capital. An analysis of simple slopes revealed that at low (-1SD) bridging social capital there was a significant positive effect of $PM_{2.5}$ on mental distress (b = .07, SE = .03, 95% CI[.02, .13], t(3103) = 2.50, p = .012, d = .09), but at high (+1SD) bridging social capital there was a significant negative effect (b = -.07, SE = .03, 95% CI[-.12, -.01], t(3103) = -2.17, p = .030, d = .08). Likewise, an analysis of simple slopes revealed that at low (-1SD) linking social capital there was a significant positive effect of $PM_{2.5}$ on mental distress (b = .35, SE = .02, 95% CI[.31, .40], t(3081) = 15.74, p < .001, d = .57), but at high (+1SD) linking social capital there was a much smaller effect (b = .13, SE = .03, 95% CI[.07, .18], t(3081) = 4.80, p < .001, d = .17). See Figures 1-2 for visual summaries of these

interactions. The Supplemental Materials (pp. S1-S2) depict analyses that account for spatial autocorrelation of the residuals for both models. In both cases, the interactions remained significant when accounting for spatial autocorrelation.

Discussion

Study 1 suggests that for counties high in certain types of social capital, the psychological burden of chronic exposure to environmental hazards is somewhat smaller. These data offer a broad, structural-level demonstration of the way that social capital may be a vital resource for communities faced with environmental hazards. One limitation of these findings is that the county is a somewhat crude geographical level of analysis, and many environmental hazards are much more localized to certain neighborhoods, often those inhabited predominantly by lower income folks and people of color (e.g., Lejano & Iseki, 2001; Maranville et al., 2009). We also did not have a measure of bonding social capital at this level of analysis. However, this study still demonstrates that the social and structural affordances of bridging and linking social capital may promote resilience to the stress of environmental hazards in tandem with proximal, psychological factors. In subsequent studies, we move to individual-level analyses of experience with CEC, stress, social capital, and coping in the context of a specific contamination event in order to augment the findings from Study 1.

Table 1. Means, standard deviations, and correlations with county-level variables (*Study 1*).

Variables	M	SD	1	2	3	4
1. Average Daily PM$_{2.5}$ (μg/m^3)	8.95	1.58	–			
2. % Frequent Mental Distress	12.21%	1.91%	.16***	–		
3. Bridging Social Capital	0[a]	1[a]	-.45***	-.35***	–	
4. Linking Social Capital	0[a]	1[a]	.08***	-.54***	.36***	–

*p < .05, **p < .01, ***p < .001

Table 2. Interaction between PM2.5 and Bridging Social Capital on the outcome of Mental Distress, with and without covariates (*Study 1*).

	Model 1: No Covariates				
Variables	*b [95% CI]*	*SE*	*t*	*p*	*R²*
Intercept	12.13 [11.73, 12.53]	.20	59.78	<.001	.13
PM2.5	.002 [-.04, .04]	.02	.12	.906	
Bridging Social Capital	-.14 [-.44, .17]	.16	.87	.384	
PM2.5 * Bridging	-.07 [-.11, -.03]	.02	3.57	<.001	
	Model 2: With Covariates				
Variables	*b [95% CI]*	*SE*	*t*	*p*	*R²*
Intercept	15.36 [14.75, 15.97]	.31	49.42	<.001	.63
PM2.5	.08 [.04, .11]	.02	4.68	<.001	
Bridging Social Capital	.05 [-.27, .38]	.16	.33	.739	
Population Density	.00003 [.000008, .00005]	.00001	2.65	.008	
Unemployment	.15 [.13, .18]	.02	10.26	<.001	
Median HH Income	-.00008 [-.00009, .00008]	.000002	40.17	<.001	
HS Graduation Rate	-.009 [-.010, -.003.]	.003	3.08	.002	
% Rural	.005 [.002., .007]	.001	5.16	<.001	
% Non-White	.01 [-.24, .27]	.13	.11	.911	
PM2.5 * Bridging	-.07 [-.11, -.04]	.02	3.86	<.001	

Note. b represents non-standardized regression coefficients. Model 1 summary: $F(3, 3103) = 156.20$, $p < .001$, $R^2 = .13$, ΔR^2 for interaction = .004. Model 2 summary: $F(9, 2643) = 490.10$, $p < .001$, $R^2 = .63$, ΔR^2 for interaction = .002

Table 3. Interaction between $PM_{2.5}$ and Linking Social Capital on the outcome of Mental Distress, with and without covariates (*Study 1*).

Model 1: No Covariates					
Variables	*b [95% CI]*	*SE*	*t*	*p*	*R^2*
Intercept	10.06 [9.75, 10.38]	.16	62.99	<.001	.13
$PM_{2.5}$	.24 [.21, .27]	.02	13.71	<.001	
Linking Social Capital	-.07 [-.36, .22]	.15	.46	.646	
$PM_{2.5}$ * Linking	-.11 [-.15, -.08]	.02	6.77	<.001	
Model 2: With Covariates					
Variables	*b [95% CI]*	*SE*	*t*	*p*	*R^2*
Intercept	14.04 [13.44, 14.65]	.31	45.59	<.001	.62
$PM_{2.5}$	.20 [.17, .23]	.02	12.54	<.001	
Linking Social Capital	.13 [-.13, .39]	.14	.96	.336	
Population Density	.00001 [-.00001, .00003]	.00001	.96	.338	
Unemployment	.16 [.13, .19]	.02	10.27	<.001	
Median HH Income	-.00007 [-.00008, .00007]	.000002	32.15	<.001	
HS Graduation Rate	-.01 [-.02, -.005]	.003	3.55	<.001	
% Rural	.003 [.0007, .004]	.0009	2.76	.006	
% Non-White	.06 [-.20, .33]	.13	.48	.632	
$PM_{2.5}$ * Linking	-.06 [-.09, -.03]	.02	3.87	<.001	

Note. b represents non-standardized regression coefficients. Model 1 summary: $F(3, 3081) = 550.30$, $p < .001$, $R^2 = .35$, ΔR^2 for interaction = .01. Model 2 summary: $F(9, 2631) = 469.80$, $p < .001$, $R^2 = .63$, ΔR^2 for interaction = .002

Figure 1. Interaction between PM$_{2.5}$ and bridging social capital on the outcome of mental distress. Shaded areas represent 95% confidence intervals around the estimated lines (*Study1*).
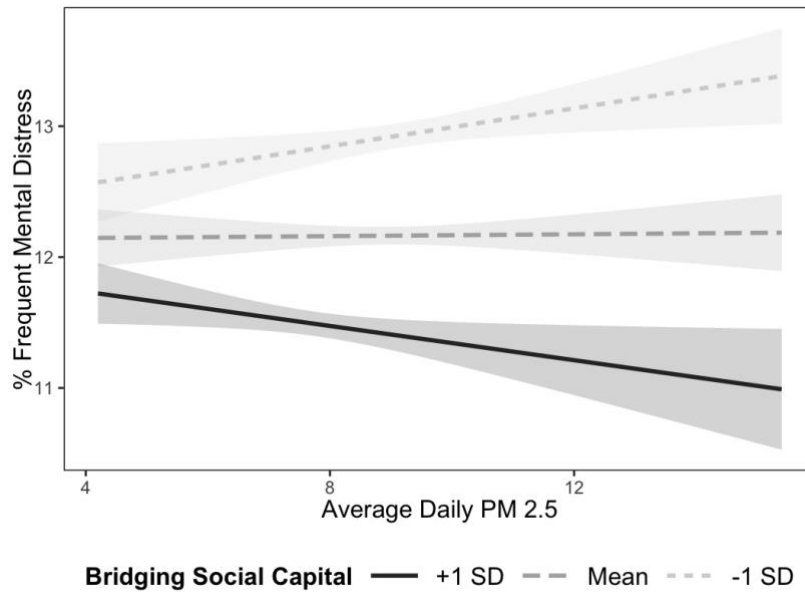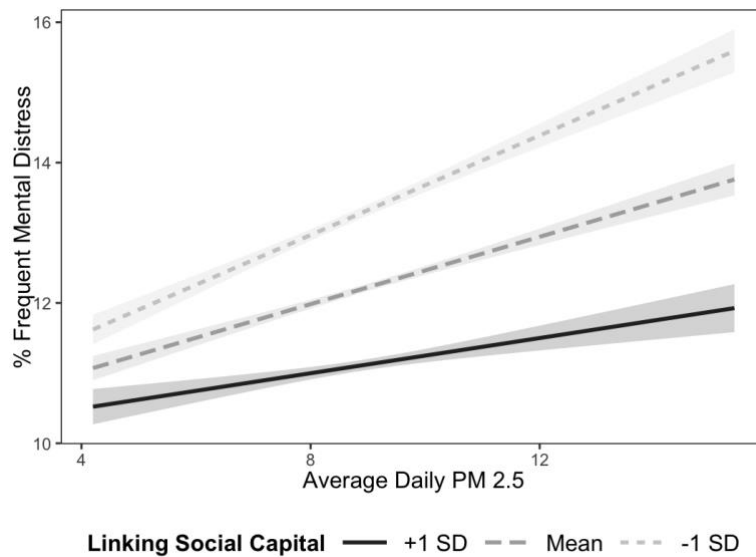

Figure 2. Interaction between PM$_{2.5}$ and linking social capital on the outcome of mental distress. Shaded areas represent 95% confidence intervals around the estimated lines (*Study1*).

STUDY 2

Studies 2 and 3 investigate the role of social capital as a buffer for the psychological

burden of CEC in the context of a specific CEC event in the Southside community of Tucson,

AZ, USA. Study 2 is a qualitative investigation of 13 interviews conducted with Tucson residents who experienced this CEC event. This study has three primary aims, in line with recommendations for the role of qualitative data in mixed-methods investigations suggested by Power et al. (2018) and by Fetters et al. (2013). The first goal is to *augment* the decontextualized quantitative findings from Study 1 by offering a thick, culturally and historically situated description of the role of social capital in the lived experiences of people who have endured the stress of CEC. This allows us to explore how perceptions of social capital may function in these subjective experiences. The second goal is to *generate* experimental materials and hypotheses that can be tested in an ecologically valid context within the Tucson community. The third goal, which can be more broadly situated within the aims of environmental psychology, is to more deeply explore the psychological aspects of social capital in the context of CEC as a complement to Study 1's focus on the ecological level. We now provide some brief historical background on the CEC incident in Tucson to situate Studies 2 and 3.

From the 1940-70s, industrial and military activity caused considerable groundwater and soil contamination in Southside Tucson, a predominantly Hispanic and low income community (U.S. Census Bureau, 2018). The Tucson International Airport Area (TIAA) site was named a federal Superfund site in 1983, and remains one to this day because of the extent of the contamination. Superfund sites consist of over 1000 areas of land that have been identified by the United States Environmental Protection Agency (EPA) as candidates for cleanup because they have been contaminated by hazardous waste that poses a threat to environmental or human health. The EPA provides institutional support to investigate and fund the clean-up of these contaminated sites. In the years since the designation of the TIAA, multiple lawsuits have been

brought against the contaminating parties, with over $100 million going to some of the Southside

Tucson residents most affected (Pima County Librarian Files, 2014).

The main contaminants of concern on the TIAA are TCE and 1,4-dioxane which may

cause kidney and liver cancer, non-Hodgkin's lymphoma, and noncancerous health issues with

the liver, kidney, reproductive system, central nervous system, and immune system (Agency for

Toxic Substances & Disease Registry, 2012; Chiu et al., 2012). The Tucson Water Department

and other agencies are currently removing these toxins from the TIAA and state that safe water

has been served to Southside Tucson since the designation of the site. However, this does not

negate the decades of active contamination and subsequent decades of uncertainty and social

conflict that community members have endured. Further, recent international concern over

contamination from the PFAS family of chemicals may re-traumatize community members

impacted by this historical contamination (Seery et al., 2010). As part of the TIAA cleanup

process, the Unified Community Advisory Board (UCAB) formed in 1995 and hosts quarterly

meetings to inform the community about the progress of the cleanup and to allow responsible

institutions to hear community concerns (Arizona Department of Environmental Quality, 2012).

Several other community organizations have formed among Southside residents to educate and

advocate for the community on CEC-related issues.

This incident of CEC provides an opportunity for an illuminating case study. While case

studies of specific events can lack generalizability (Yin, 2003), we believe that the use of

multiple methods, and the congruence of the results of this case study with the foregoing

geographic results, suggest that much can be learned about CEC and environmental justice

broadly from this case study. Based on Social Capital Project data from Study 1, Pima County

(where Tucson resides) scored in the 7th percentile for both bridging and linking social capital.

Likewise, an inquiry of the US EPA's Environmental Justice Screening Tool (United States Environmental Protection Agency, 2020) revealed that the area of the TIAA is in the top quintile for all 11 measures of environmental injustice, while other areas of Tucson scored in the top quintile for just two of these indicators. Thus, the Southside Tucson community may have low social capital and high risks of exposure to environmental hazards, suggesting that investigating the interplay between CEC, social capital, mental health, and collective action in this context is a worthwhile pursuit.

Method

Study 2 involved a thematic analysis of 13 interviews conducted with residents of Tucson on the experience of CEC. The results reported for this study focus on a small subset of the full coding scheme developed by the lead author, and represent just one way in which these data will ultimately be utilized.

Participants

Interviewees ($n = 13$) consisted of adults, some of whom grew up or currently live on the TIAA ($n = 9$) and some of whom live elsewhere in Tucson, but had been involved in advocacy surrounding the TIAA ($n = 4$). Interviewees were recruited via presentations at public health community teach-in events and via regular attendance and presentations at the meetings of community organizations. By recruiting from these events – which could be called purposeful sampling (Palinkas et al., 2015) – we ensured that participants were reasonably informed and active in local CEC-related issues, and could thus provide detailed accounts of relevant experiences. However, the sample represented in Study 2 is not necessarily representative of the broader (Southside) Tucson community, who may not be as informed or active in CEC-related issues. See detailed demographic information in Table S3 in the Supplemental Materials.

Researchers and Positionality

The authors do not have personal experience with CEC as residents of Southside Tucson. However, regular attendance and participation in community meetings by the authors over the past five years was integral to building trust and recruiting participants for this study. It is our explicit goal to leverage our relationships with community groups, public health professionals, researchers, and local officials to advocate for community needs and facilitate productive connections between these groups.

Procedure

Semi-structured interviews were conducted by two researchers between March and August of 2019. The interview questions were developed based on past literature (Edelstein, 2018), focusing on how interviewees learned about the contamination, experiences of contamination-related stress, coping mechanisms, and suggestions for policy and practice that would help the community move forward. Other topics came up in the interviewees' responses and were probed further at the interviewers' discretion. Interviews lasted between 36 minutes and 90 minutes, with a mean of 52 minutes. With participant permission, interviews were audio recorded, transcribed verbatim, and anonymized.

Following the semi-structured interview, interviewees completed a demographic questionnaire, were debriefed, and compensated with $20. The debriefing consisted of information from the EPA and the Tucson Water Department about the history of the TIAA and the current state and safety of the water. Interviewers held debriefing discussions after each interview to identify emerging topics of interest, commonalities, and discrepancies across interviews (Saldaña, 2013).

Theoretical Approach

For the analysis presented in this study we adopted a thematic analysis approach, and primarily focused on semantic themes (i.e., those more explicitly present in the words of participants; Braun & Clarke, 2006) that relate explicitly to prior theorizing on social capital and CEC (Hayes, 2013). This approach to analysis is in line with the primary aims of Study 2: to *augment* the quantitative findings from Study 1, and to *generate* experimental hypotheses for addressing stress through social capital in Study 3 (Power et al., 2018). A semantic thematic analysis serves these purposes well as it allows us to identify common experiences of stress specific to the community experience of CEC in more humanized and concrete ways than was possible in Study 1, and it allows us to identify the ways in which impacted community members speak about the presence or non-presence of social capital, and how they might employ it to cope with CEC. While the data collected for Study 2 offer rich histories, personal experiences, and interpretations of the collective problem of CEC in Tucson which would lend themselves to a more thorough and reflexive qualitative inquiry (something the authors intend to do in the future; Holland et al., 2006), here we present only one way of analyzing these data in accordance with the relatively circumscribed goals of the present mixed-methods investigation.

In traditional quantitative research and in many qualitative approaches that stem from more positivist epistemological standpoints, researchers seek to demonstrate objective findings with minimal interference from subjective elements. Much qualitative work under the umbrella of thematic analysis, however, adopts a more constructionist epistemology characterized by a focus on the social construction of researcher and participant meanings as a function of various cultural and political discourses that arise in part because of the research process (Braun & Clarke, 2006). Given that the mixed methods approach of the present project involves both empirical and more constructionist approaches across the three studies, we adopted a middle

ground "pragmatist" epistemology in our analysis in Study 2, as is common in qualitative inquiry

in mixed-methods investigations (Braun & Clarke, 2021; Doucerain et al., 2016). Indeed, the

very nature of CEC may necessitate a pragmatic approach to analyzing social scientific evidence,

as is central to Kroll-Smith and Couch's (1991) ecological-symbolic perspective on such

disasters. This perspective acknowledges that impacted communities experience CEC as a deeply

symbolic, socially constructed phenomenon (i.e., justifying a constructionist approach).

However, it also acknowledges that this symbolic understanding of CEC is not constructed "out

of thin air" (Kroll-Smith et al., 2000, p. 54), but rather stems from a fundamental

interdependence of social constructions and the material reality of a given (disrupted)

environment (i.e., justifying a pluralistic/pragmatic combination of constructionist and realist or

positivist approaches).

Method of Coding and Analysis

We followed the six steps of thematic analysis suggested by Braun and Clarke (2006):

familiarization, generation of initial codes using both inductive and deductive coding, searching

for themes, reviewing themes in relation to coded text, defining and naming themes, and writing

results using compelling examples from participant responses. These steps were undertaken in a

cyclical and iterative manner. This involved early familiarization with the data through

researcher presence in the interviews, transcribing materials, and reading and re-reading each

interview. We began to generate initial codes first through debriefing discussions between the

first and second author who were both present at each interview (McMahon & Winch, 2018),

and then through deeper familiarization with the data after transcription.

A first coding scheme was arrived at through group consensus based on a combination of

past literature (Calloway et al., 2020; Edelstein, 2018; Szreter & Woolcock, 2004), expert input

from the first author's master's committee, and debriefing discussions between the first and

second authors during data collection. Thus, this coding scheme included both deductive coding

(i.e., analyst-driven coding based on prior theory) and inductive coding (i.e., data-driven coding

derived directly from the participant responses). The first author utilized the software NVivo11

to organize and code interviews at this stage (QSR International Pty Ltd., 2015) using widely

employed coding methods for both deductive and inductive coding (Hayes, 2013; Ryan &

Bernard, 2003). A first cycle of coding revisions by the first author was undertaken to identify

additional codes and combine more redundant ones, which were then discussed and revised by

all authors until group consensus was achieved. Finally, the first author conducted a second cycle

of coding revisions to refine and focus the codes according to theory-driven themes relevant to

Edelstein's (2018) typology of CEC-related stressors and Szreter and Woolcock's (2004)

typology of social capital within the existing data (Braun & Clarke, 2006; Saldaña, 2013). These

themes were then reviewed by comparing relevant coded material to its overarching theme to

assess whether coherent patterns of meaning were well-represented by selected data. After this

stage, themes were named and defined based on Edelstein's (2018) typology of CEC-related

stressors and Szreter and Woolcock's (2004) typology of social capital. These themes were again

discussed between all authors and group consensus on the adequacy of the themes was achieved.

  Because the coding and theming of the data were primarily conducted by the first author

(albeit with several rounds of discussion and achieving group consensus on the process) and no

attempts were made to quantify agreement between multiple coders (Braun & Clarke, 2013),

concerns with validity and methodological integrity may be raised. Several steps were taken to

ensure validity and integrity in our analysis based on recommendations from Onwuegbuzie and

Leech (2007): we ensured prolonged engagement and persistent observation with the activists

interviewed in the study to build trust through regular attendance at community meetings over several years, we achieved group consensus among researchers at multiple stages of the analysis process, and we engaged in "member checking" by sharing the results of this analysis with and soliciting feedback from the activist groups from which participants were recruited.

Results

The resultant constellation of themes generated through our analysis included *sources of stress* associated with CEC which were separated into three subthemes for physical, social, and historical stressors in line with Edelstein's (2018) typology, and *coping mechanisms* for the stress of CEC which were also separated into three subthemes for bonding, bridging, and linking social capital as coping mechanisms in line with Szreter and Woolcock's (2004) typology.

Sources of Stress

Material Impacts on Environment and Health. All interviewees expressed concerns for the material impacts of CEC on both the physical environment and on physical health, as well as the financial impacts that these had on their lives. One of the primary ways that concern about the safety of the physical environment manifested was that most participants refused to drink water from the tap, in spite of consistent public health messaging that the water is safe. When asked if she used the tap water in her home, one participant responded:

> *"No, we drink bottled water… I mean gotta do laundry, gotta bathe. Very careful when*
>
> *we're in the shower, you know, about it getting in our faces, you know. (P2)*

Concerns about the safety of the water were related to concerns about potential health impacts. All interviewees felt that consumption of the water could cause negative health impacts, such that many interviewees attributed personal health issues to the water they had consumed. Most also expressed concerns about the impact that the water may have on children specifically,

and many described children they knew who had experienced negative physical health impacts

attributed to the water. One participant described the omnipresence of such concerns for her

community:

> *All these people are dying of cancer… my mom was diagnosed with cancer… then the*
>
> *people down the street… little boy with leukemia, the next-door neighbor died of cancer,*
>
> *the man across the street died of cancer, the two girls in the [neighborhood] have cancer.*
>
> *Then I got cancer, and then another friend up the street, around my corner… she got*
>
> *cancer, same time I did… and they did the genetic testing also, and it wasn't hereditary.*
>
> *At all. (P8)*

Another described the numerous people in his immediate family and close social circle with

illnesses they attribute to the water:

> *And my old girlfriend, she had lupus. And she got some uh… and my sister's got lupus.*
>
> *My mom had um...I don't know what all she had. Everybody's got a little bit of*
>
> *something. And I think it's due to the water we've been drinking for years and years and*
>
> *years. (P11)*

He went on to describe the kind of toll that the perceived ubiquity of illness and death takes on

people in his community:

> *When you get talking to people and, you know, this person died, that person died, this*
>
> *person died. You know, when's it gonna be my time? (P11)*

Financial burdens were frequently mentioned, including issues with dropping property

values due to proximity to the TIAA and inability to pay medical bills. The invisibility of the

contamination, coupled with the ubiquity of illness and death attributed to it, contributed to a

pervasive sense of uncertainty and powerlessness to effect change:

A lot of us are stuck there, you know what I mean? Cause we don't have the finances to

move out. You know what I mean? Like we can say, "okay we're gonna get up and sell

our house for $90,000 and go live in another beautiful home." It's not gonna happen.

(P8)

One participant described the stress and injustice of these financial and health burdens thusly:

The quality of life here in this community has gone down… where people would be

putting money into education for themselves and their children, they're putting into the

hospitals. They're putting into the doctors and the clinics. And that's not right. (P12)

Social Stressors. Interviewees described three main social stressors: (1) social disunity,

(2) loss of trust in institutions, and (3) environmental injustice and racism. Most interviewees

expressed concerns with social disunity between community members. One source of disunity

stemmed from being excluded from past lawsuits that had compensated impacted Southside

residents, with some interviewees suggesting that neighbors and friends had intentionally kept

their involvement in the lawsuits secret:

Nobody came to us and told us anything when the lawsuit came to a head… they were

told back then, "the more people you tell then the less money it is for you." That's why

they skipped our house. (P9)

Rifts between community organizations were another common source of disunity.

However, a lost sense of trust in public health and government institutions that were expected to

prevent contamination in the first place was a more prominent social stressor. Some felt that

these institutions had deliberately lied about the safety of the water in the past, making trust

difficult to regain in the present. As one participant described:

It goes back to the 40's…and they brought it to the city officials and it was a settlement, a

court settlement…Why in their right mind, if the city officials and the county officials

knew what was happening there with the water contaminated… why were the builders

allowed to build homes and schools in that area? That shouldn't've ever happened. We

wouldn't be having this conversation, you know? And they kind of put it under the rug, I

feel. (P5)

Another participant discussed the ways that even the positive presence of the Tucson Water

Department in the present could not make up for the loss of trust suffered in the past:

Well, we don't trust Tucson Water. We just don't trust them. They come to meetings, they

do a lot of events… and they have lovely charts. They bring us a lot of very nice scientific

information… And I don't know. I just, I've lost my trust of city water…so they've got a

lot of trust to earn again. (P13)

Lost trust was exacerbated by experiences of *institutional delegitimization*, or the

perception that community concerns were being invalidated and not taken seriously by various

officials (Calloway et al., 2020; Sullivan et al., 2021). Institutional delegitimization occurred

during meetings between community members and local officials when officials would imply

that community concerns about contamination-related health issues were overblown. One

participant described the mismatch between the trauma she had experienced as a result of CEC

and the lack of empathic response from various institutions:

We shouldn't be looked at as if we could have children die in our homes and we're not

gonna be, um, we're not gonna be somehow traumatized by these things. We're

traumatized. Our stories of how and what we've gone through are just "no big deal, who

cares?" When we're being ignored, it's wrong. It's not okay and it's not acceptable.

These people are people… they've earned some respect from our government and from

our health system. (P6)

Many interviewees felt that the contamination in Tucson's Southside represented an

environmental justice issue, and several interviewees explicitly attributed the issue to racism

against Latinos and other people of color. Many interviewees not only felt that the contamination

happened intentionally in the part of town where more people of color and low-income people

lived, but also felt that the inadequate response to community concerns was attributable to racist

and classist institutional practices. One experienced activist summarized it thusly:

Do they put it up in the east side? In the foothills? No. They put it down here. Where

people of color, people with low socioeconomic backgrounds, and less likely to fight

them. (P12)

Another described the kinds of delegitimization the community had experienced over the years

as attributable to racist victim-blaming, where past institutional representatives would attribute

clusters of disease on the southside to stereotyped diets and lifestyle choices:

[Former] Director of Pima County Health Department, her attitude was that the people

on the south side, "it's not a big deal there's nothing going on. They're not dying like

flies down there. And yeah, they're sick, they have a higher rate of diseases than other

parts of town, but it has to do with their diet, their lifestyle, they drink too much, you

know they eat the wrong things, they are overweight." A real blame the victim types of

attitudes that were incredibly racist in my opinion. (P4)

Interviewees were also concerned that the community's health and wellbeing had been

exploited in favor of corporate interests, suggesting that elected officials cared more about

appeasing corporations than addressing the community's concerns. When describing why the city had not done more to curb contamination early on, one participant said:

> *Why? Because Grand Central Aircraft was employing about 4,000 people. It wasn't good for the economy. You know, so, it was hustling and bustling in the 50's and whatnot. (P5)*

> **Historical Stressors.** Many interviewees discussed concerns specific to the chronic time course of the contamination, including changes to core beliefs about the safety of the environment. This included nostalgia for the presumed safety of the environment and water before discovering the contamination, and feelings of regret for having potentially exposed themselves or their children to contamination before having known about it:

> *And it's just like, you know you think that you're doing well by letting your kids play sports, and be doing exercises. And it should be. We should have been healthy people 'cause we were out there running around and eating right and playing, you know? And being in a community, being on a team, supporting one another in school and everything. That's supposed to be a good thing. A healthy thing. But for us, it didn't turn out that way. For us it turned out to be something that made us more susceptible to falling prey to this poison. (P12)*

For most of the interviewees, there was a sense of cyclicality in the experience of the CEC, from initial discovery, to the onset of health effects attributed to contamination, to the discovery of new contaminants. Each event brought back feelings associated with the initial discovery, and each event was characterized by similarly delegitimizing responses from institutions. For some, this cyclicality engendered a sense that the community had little power to stop the cycle, suggesting that it would continue on for future generations to contend with:

I believe that it's gonna go on and on. Unfortunately, it's gonna have to happen for the

next generation, somebody's gotta teach them to fight for… what they believe is right.

Unfortunately, that's just what it is. We thought maybe [NAME] back in the 80's that she

had made that difference, that she had put a stop to all this stuff and that this would never

happen to a community again… that's what we all hope for, but it's not in reality, it's not

happening. We just go from generation to generation to generation with the same issues.

(P6)

Coping with Contamination

Many of the coping mechanisms included individual-level actions taken by interviewees. These included mitigating potential exposures to contamination (e.g., purchasing bottled water, boiling or filtering tap water), self-educating about historic and ongoing contamination, and fostering individual emotional resilience to the stress and uncertainty of contamination. Given the scope of the present study, however, we focus on coping mechanisms that concern the perception and use of bonding, bridging, and linking social capital. For each, we outline ways that these forms of social capital have been utilized to cope with the stress of CEC, but also how they have been disrupted to varying degrees by the material, social, and historical impacts of living through CEC.

Bonding Social Capital. Bonding social capital – networks of support stemming from family and close community – was leveraged as a coping mechanism for interviewees who were able to lean on close others for social and emotional support. Specifically, several interviewees suggested that solidarity with other community members who were facing similar contamination-related difficulties allowed them to experience validation from people who

understood the unique stressors and uncertainties of CEC. One participant recounted the relief

she felt from sharing stories of CEC-related experiences with others in her community:

> *"I'm learning that a lot of my illnesses, and a lot of things that I've gone through, I'm not*
>
> *alone. That in the group I'm finding out, you know, a lot of them have had miscarriages,*
>
> *a lot of them, you know, have had cancer, a lot of them have mental problems… I guess*
>
> *me going to these groups and learning a little bit more is like, I'll be honest, I feel like a*
>
> *relief. Like, hey, it wasn't me. You know, it wasn't something I did." (P7)*

Bonding social capital was also employed as a coping mechanism for interviewees who

were inspired to continue seeking justice and to create a better world for future generations.

Several interviewees drew such inspiration from focusing on their fight for a safe environment

for children, grandchildren, nieces, and nephews:

> *What makes me keep going is, and what keeps my spirit up and everything, is my*
>
> *grandkids and my children. That's my fight. You know, I just think of them, and I'm like,*
>
> *"nope, I'm not giving up." (P8)*

However, the material, social, and historical impacts of CEC have been shown to corrode

bonding social capital in several key ways as well (Cline et al., 2014; Davidson, 2018). One way

that this occurs is through the tragic loss of life associated with exposure to contamination, as

expressed by many of our participants:

> *Actually, my husband passed away. He passed away from Leukemia… And he was young.*
>
> *He was only 61 when he passed away. He still had a lot of life to live… We believe from*
>
> *the water. From the water. (P2)*

Another key way that this occurred was through the kinds of social disunity discussed above,

such as disagreements (even between family members) about the extent of risks from

contamination, and exclusion from lawsuits by neighbors. One participant recounted how his efforts to get his aunts and uncles involved in activism were thwarted by another uncle that worked for the water department:

> *It's an issue. It's very frustrating…I told my dad's sisters and brothers out there, and one uncle who worked for the water department, he took the sign I put up and threw it away. And he told them – I had them come to the meetings – and he told them "Ah, it's bullshit, the water's been clean for years." No, it's not…That sucks, your family. So now, what do they do? They don't go to the meetings. (P9)*

Bridging Social Capital. Bridging social capital – respect, mutual support, and networking across loosely connected communities – afforded several different ways of coping that were evident across interviews: by (1) joining community organizations, (2) educating other community members who were not otherwise connected to grassroots activism in the community, (3) participating in environmental protests and collective actions, and (4) connecting with broader social and environmental movements. Several interviewees felt that joining, organizing, and leading community groups that advocated for CEC-related issues gave them a sense of purpose and agency to combat contamination, and allowed them to achieve more than if they had worked alone. Sharing information and educating community members about the history and potential health impacts of contamination – whether through community organizations, teach-in events, or going door-to-door – was an important way to empower the community to effect change. One participant, after recounting the death of her daughter to CEC-related health issues, explained how the work she had done to educate and organize members of the community across broad networks helped her regain a sense of agency over her own life, which corresponded with the trajectory of the broader movement in her community:

I was depressed, I had anxiety, I used to hear her voice, I was always dreaming of her,

you know. And I always felt like a failure, that I didn't do enough. I didn't do enough for

her… I'm going to do my own research… I was, my mind was back, it was crisp, I was

healthy again. I started asking questions, I started banging on people's doors, I started

going door to door… my group began to grow. I started a non-profit at the time, I started

the movement, an environmental justice movement. Before you knew it, we had the whole

community with the same language, talking the same questions. (P6)

Some interviewees also suggested the importance of public acts of protest (e.g., marches,

demonstrations in front of government buildings) to demonstrate the dissatisfaction of people

from different communities:

"And the community started rising up. We organized. I organized a demonstration with

almost no notice, a hundred people showed up out front the federal building." (P4)

Some interviewees had been involved in environmental justice movements for several

decades, and spoke to the connections that had been made between Tucson's Southside

community and broader movements for environmental justice. Interviewees mentioned past

connections with prominent activists, journalists, organizations, and national coalitions. These

connections between more distant communities encouraged a sense of solidarity that went

beyond the physical boundaries of the contamination in Tucson, and plugged the local

community into a movement with a grander narrative of resistance and more social, economic,

and political capital:

I've connected as a PFAS National Coalition member, I'm connected with every state

that's been affected, with the affected community members. And we've been connected

with many, many services. (P6)

As discussed above, one key way that bridging social capital was undermined in this context was through the rifts that had formed between community groups. Another important factor, which relates to the historical dimension of CEC impacts, was burnout from having been involved in activism for so long on the same issue. Some participants who had been in leadership positions across several decades described feeling burned out and stepping back from activism, which would at times lead to the stalling of progress:

> *That's how I became involved in the TCE contamination and I stuck with that for a few years. But I started getting burnt out. Was working too hard all the time, got burnt out…So I dropped out for a while from the situation. (P4)*

Linking Social Capital. The final subtheme of interest was the use of linking social capital, or connections with powerful institutions, to cope with CEC. As discussed above, the vertical connections of linking social capital were often strained or broken by the loss of trust, institutional delegitimization, and environmental injustice faced by the community. However, interviewees still expressed that being able to re-form broken links with powerful institutions and to create new ones were important means of coping with CEC. Specifically, many interviewees expressed a sense of pride in being able to come together as a community to influence local elected officials to act on the community's behalf. Ten interviewees discussed the importance of times when the community's voices were heard and validated by officials. For instance, one experienced activist and leader described the several instances when the community's activism were well-received and reciprocated by elected officials:

> *And we went and spoke with [City Official] and at first, they couldn't seem to get what we were saying… it wasn't until we started to explain it to them… and they started looking at it. So, they've done great. And [US Congressmen] helped us with that other*

thing. And there's always talk, 'politicians aren't doing anything…' But, you know, you

go talk to them, and they'll help you. (P12)

This suggests that though some trust had been broken, there may be avenues for rebuilding trust to facilitate networks of linking social capital. Another way that some interviewees leveraged linking social capital as a coping mechanism was by moving beyond local institutions that had lost community trust, and working directly with federal institutions or other national-level organizations. By making such connections, some interviewees were able to further connect Tucson's southside community with broader networks of institutional support:

The movement is well worth it, you know, I've gone to Washington, DC. I've connected

with all the right people, powerful people, people that know what they're doing. And

that's what's helping this community right now. (P6)

We had some allies. The Sierra Club were like mentors. They had lawyers that would

come and help us. They had the ability to raise a little bit of funds here and there so that

we can send samples outside of here. (P12)

Discussion

Study 2 offers an augmentation of the findings from Study 1 in a number of ways. Study 2 explores the lived experience of individuals exposed to an incident of CEC to demonstrate specific stressors that occur during long-term exposure to environmental hazards, including concerns with physical health and safety, secondary social stressors, and historical stressors that occur as a function of the chronic nature of exposure. These interviews further augment the findings from Study 1 by outlining specific ways that different forms of social capital may buffer the stress of CEC for an impacted community. Namely, the close connections of bonding social capital may provide validation from others with similar experiences, the broader associations of

bridging social capital may help communities stay educated and feel empowered, and vertical networks of linking social capital may help communities to regain institutional trust and secure key services and policy-supported, long-term change.

If social capital may be an important buffer and coping mechanism for the stress of contamination, and the social processes following an incident of contamination can severely disrupt social capital, it follows that one productive area for psychological research is to develop interventions that restore (perceptions of) social capital. Findings from Study 2 suggest that in Tucson's Southside community, intervening to improve bonding, bridging, or linking social capital could be an effective way to increase community resilience. We take a general, experimental approach to manipulating perceptions of social capital in Study 3. Specifically, we manipulate both the salience of the threat of CEC, as well as perceptions of social capital, using real materials and information gleaned from Study 2 in an attempt to experimentally test the potential role of social capital as a buffer for CEC-related stress, and to test the feasibility of intervening on perceptions of social capital in the context of CEC.

STUDY 3

Study 3 offers an ecologically valid experimental investigation of responses to the threat of CEC. The purpose of Study 3 is to provide more generalizable evidence of the role of social capital in promoting efficacy and adaptive coping in response to information about contamination. This study employs a 2(CEC threat) × 2(perceptions of social capital induction) design. The design of Study 3 was influenced by theorizing on social capital (Aldrich & Meyer, 2015; Szreter & Woolcock, 2004), as well as past work on collective action in the psychology literature (Jugert et al., 2016). Building on the findings of Study 2, we hypothesized that in the face of the threat of CEC, perceptions of social capital would increase adaptive responses to CEC

– indexed here as perceptions of efficacy – and decrease less adaptive coping with CEC –
indexed here as denial of the threat of CEC.

For the interviewees in Study 2, the threat of CEC was ubiquitous due to intimate
experiences with CEC spanning several decades. For Study 3, we sampled more broadly from
the Tucson community for whom the threat of CEC is typically less salient, making it important
to manipulate the threat of CEC. Because the CEC experience is characterized by ambiguity and
uncertainty, the threat of CEC lends itself to experimental manipulation (see Sullivan & Young,
2020). Study 2 showed that broken (and sometimes regained) community and institutional trust
(i.e., perceptions of social capital) were important aspects of the social dimension of CEC. Thus,
we sought to manipulate perceptions of social capital in Study 3. Based on an a priori power
analysis, we aimed to recruit a sample of 212 participants to detect a medium effect size for
hypothesized interactions.

Method

Participants

The initial sample in Study 3 was comprised of 296 people. Participants were initially
recruited in-person in various locations around Tucson in early 2020 before COVID-19
restrictions took effect ($n = 39$). The rest of the participants were recruited online via
geographically targeted social media advertisements and posts in community forums on social
media websites in late 2020. Many of the respondents recruited online did not complete the
survey ($n = 111$), and some did not live in or near Tucson ($n = 6$). These respondents were not
included in analyses, leaving a final sample of 179 Tucson residents (19.6 % recruited in-person;
19.7% men, 76.8% women, 1.5% transgender, 2% gender unreported; $M_{age} = 49.12$, $SD_{age} =$
16.82; 78.3% White, 13.8% Latino/Hispanic, 1% Black or African American, 3.4% American

Indian or Alaskan Native, 4.4% Asian, 1% Native Hawaiian or Pacific Islander, 5% "Other").

Participants reported living in Tucson for an average of 19.64 years (SD = 17.42), and 12.8% of

the sample reported living in Southside Tucson (near the TIAA). Though the final sample was

smaller than the target, a sensitivity power analysis conducted in G*Power (Faul et al., 2009)

revealed that this sample would be sufficient to detect a Cohen's d of .42 at 80% power for the

intended analyses.

Procedure

After reading informed consent and agreeing to participate, all participants completed

demographics measures, were randomly assigned to a CEC threat condition or a control

condition, completed a situational stress measure, then were randomly assigned to either

complete a perceptions of social capital induction before or after completing the rest of the

dependent measures. All dependent measures were assessed on a 7-point Likert scale (1 =

Strongly Disagree, 7 = Strongly Agree) unless indicated otherwise[1]. Text of items can be found

in Supplemental Materials (p. S9).

Demographics. All participants reported age, gender, race/ethnicity, primary city of

residence, length of residence, and whether they lived in Southside Tucson. Participants reported

their subjective socioeconomic status using the MacArthur Ladder Scale on a scale form 1-10 (M

= 5.74, SD = 1.94; Singh-Manoux et al., 2003).

CEC Threat Manipulation. Participants in the CEC threat condition read a brief fact

sheet about water contamination in Tucson. The fact sheet described the historic contamination

in Tucson, the routes of exposure and health effects of the contaminants, and the concept of

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[1] The measures presented for Study 3 represent only part of the full study, which was conducted as part of a Master's project. Measures not included in the present study include measures of temporal orientations and future behavioral intentions, many of which could not feasibly have been done during the COVID-19 pandemic (e.g., attending a community meeting about CEC).

emerging contaminants (e.g., PFAS). All information presented was true and was based on fact

sheets provided by the Tucson Water Department and the EPA; however, the fact sheet was

intentionally designed to elicit concern about contamination.

In contrast, participants in the control condition read a comparable fact sheet about the

Tucson Water Department. It included reassuring information on the Tucson Water

Department's role in water quality testing, communicating with and educating the public, and

promoting water sustainability. The information was non-threatening, but still briefly mentioned

contamination. Both factsheets can be found in the supplemental materials (Figures S1-S2).

These materials represent ecologically valid manipulations of CEC threat because many water

agencies actually mail out similar information in water bills, and many people find out about

local contamination through media outlets that report similar information (e.g., Davis, 2019).

Stress. After the threat manipulation, all participants completed a 3-item measure of

stress adapted from previous research (Mendes et al., 2007; Sullivan & Young, 2020). Items

were aggregated to form a reliable composite ($M = 4.40$, $SD = 1.77$; $\alpha = .933$).

Perceptions of Social Capital Induction. All participants read a brief factsheet about

various kinds of social capital in response to potential water-related issues (See Supplemental

Materials Figure S3). Participants were randomly assigned to read this factsheet either before or

after filling out the rest of the dependent variable measures. Manipulating the order of

appearance allowed us to experimentally manipulate perceptions of social capital, without

withholding this important information. This factsheet was similar to collective efficacy

manipulations used in previous research (Jugert et al., 2016), though it focused on the

importance of intracommunity social networks, and the presence of networks of linking social

capital between the community and local institutions. Specifically, it discussed the importance of

working with fellow community members (bonding and bridging social capital), and the

importance of connecting the community to local institutions (linking social capital) by

encouraging communication with officials and by highlighting UCAB as a real organization that

meets regularly in Tucson to that end. After reading the factsheet, participants were given the

opportunity to leave their contact information in order to receive information about future

community meetings. Almost half of participants (47.2%) provided contact information.

Efficacy. All participants rated their agreement with two items that assessed efficacy in

dealing with contamination. We consider efficacy to be an indicator of adaptive or proactive

coping with the threat of CEC. Items were moderately correlated ($r = .37$) and were aggregated

($M = 5.39$, $SD = 1.10$).

Denial of CEC Threat. All participants rated their agreement with a two-item measure of

denial of the threat of CEC, based on common responses to CEC among community members

who have not been substantially impacted (Edelstein, 2018). We consider denial to be an

indicator of less adaptive or emotion-focused coping in the context of CEC threat. These items

were moderately correlated ($r = .62$) and were aggregated to form a measure of denial of CEC

threat ($M = 2.20$, $SD = 1.20$).

Results

Cell sample sizes, means, and standard deviations, and correlations between variables,

can be found in Supplemental Materials (Tables S4-S7).

Main effects of CEC threat manipulation

We tested to see if participants in the CEC threat condition reported more stress than

those in the non-threat condition. An independent samples t-test showed that participants in the

CEC threat condition reported that the information they read was more distressing ($M = 5.36$, *SD*

= 1.15) than those in the control condition (*M* = 3.44, *SD* = 1.78), *t*(177) = 8.64, *p* < .0001, *d* =

1.29). This suggests that the CEC threat manipulation was successful in elevating concerns about

the threat of contamination. There were no main effects of CEC threat on efficacy (*t*(177) = .32,

p = .753, *d* = .05) or denial (*t*(177) = -.29, *p* = .770, *d* = -.04).

Interactions between CEC threat and social capital induction order

We tested for interactions between CEC threat condition and perceptions of social capital

induction on efficacy. We regressed efficacy on CEC threat condition, social capital order

condition, and their interaction term into the same model, and found a significant interaction, *b* =

.69, *SE* = .33, 95% CI[.04, 1.34], *t*(175) = 2.08, *p* = .039, *d* = .31 (see Figure 3 and Table 4).

Probing this interaction, when participants had not yet completed the social capital induction

there was no effect of CEC threat on perceptions of efficacy, *b* = -.28, *SE* = .23, 95% CI[-.72,

.174], *t*(175) = -1.22, *p* = .225, *d* = -.18. However, when participants had already completed the

social capital induction there was a non-significant positive trend for the effect of CEC threat on

perceptions of efficacy, *b* = .41, *SE* = .24, 95% CI[-.06, .88], *t*(175) = 1.72, *p* = .088, *d* = .26.

Figure 3. Interaction between CEC threat condition and perceptions of social capital order
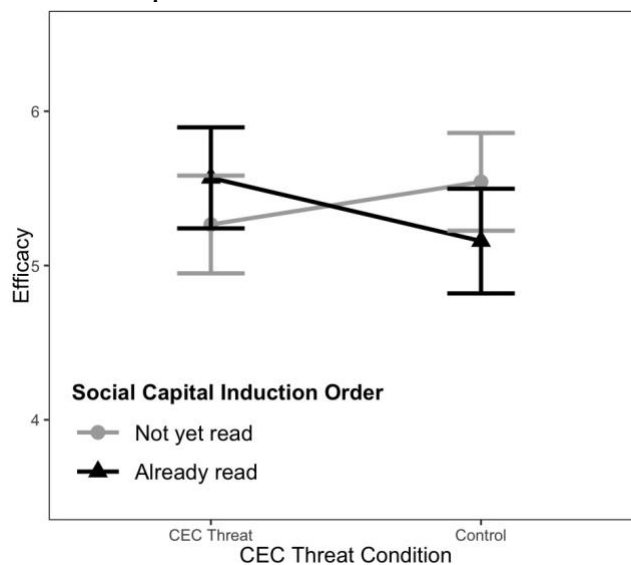condition on efficacy. Error bars represent 95% confidence intervals.

Table 4. Interaction between CEC Threat and Social Capital Induction on the outcome of Efficacy (*Study 3*).

Variables	*b [95% CI]*	*SE*	*t*	*p*	R^2
Intercept	5.57 [5.24, 5.90]	.17	33.57	<.001	.025
CEC Threat [a]	-.41 [-.88, .06]	.24	1.72	.088	
Social Capital Induction [b]	-.30 [-.76, .15]	.23	1.31	.192	
CEC Threat * Social Capital	.67 [.04, 1.34]	.33	2.08	.039	

Note. b represents non-standardized regression coefficients. Full model summary: $F(3, 175) = 1.49$, $p = .219$, $R^2 = .025$, ΔR^2 for interaction = .021.
[a] CEC Threat was dummy-coded such that 0 = non-threat condition, and 1 = CEC threat condition.
[b] Social Capital was dummy-coded such that 0 = those who had not read the social capital induction before completing dependent measures, and 1 = those who had read the social capital induction before completing dependent measures.

We regressed denial on CEC threat condition, social capital order condition, and their interaction term in the same model, and found a significant interaction, $b = -.97$, $SE = .36$, 95% CI[-1.68, -.27], $t(175) = -2.73$, $p = .007$, $d = -.41$ (see Figure 4 and Table 5). Probing this interaction, when participants had not yet completed the social capital induction there was no effect of CEC threat on denial, $b = .40$, $SE = .25$, 95% CI[-.08, .89], $t(175) = 1.65$, $p = .101$, $d = .25$. However, when participants had already completed the social capital induction there was a significant negative effect of CEC threat on denial, $b = -.57$, $SE = .26$, 95% CI[-1.08, -.06], $t(175) = -2.20$, $p = .029$, $d = -.33$.

Further exploratory analyses for Study 3 which found that social capital perceptions may be especially relevant for racially/ethnically minoritized individuals can be found in Supplemental Materials (p. S11-S14).

Figure 4. Interaction between CEC threat condition and perceptions of social capital order condition on efficacy. Error bars represent 95% confidence intervals.
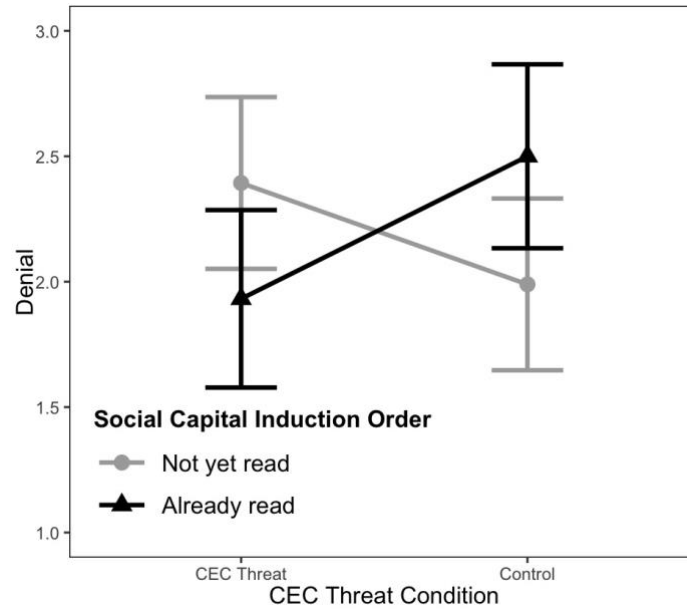
Table 5. Interaction between CEC Threat and Social Capital Induction on the outcome of Denial (*Study 3*).

Variables	b [95% CI]	SE	t	p	R²
Intercept	1.93 [1.58, 2.29]	.18	10.78	<.001	.041
CEC Threat [a]	.57 [.06, 1.08]	.26	2.20	.029	
Social Capital Induction [b]	.46 [-.03, .95]	.25	1.85	.066	
CEC Threat * Social Capital	-.97 [-1.68, -.27]	.36	2.73	.007	

Note. b represents non-standardized regression coefficients. Full model summary: $F(3, 175) = 2.52$, $p = .059$, $R^2 = .0414$, ΔR^2 for interaction = .0408.
[a] CEC Threat was dummy-coded such that 0 = non-threat condition, and 1 = CEC threat condition.
[b] Social Capital was dummy-coded such that 0 = those who had not read the social capital induction before completing dependent measures, and 1 = those who had read the social capital induction before completing dependent measures.

Discussion

Study 3 provides an important step toward integrating social capital into the psychology literature on responses to environmental issues. Study 3 suggests that when the threat of CEC is accompanied by information about the importance and presence of social capital, people may experience increased perceptions of efficacy and may engage in less defensive denial. These findings underscore the role that social capital may play in driving more adaptive responses to

environmental catastrophe. In an applied sense, Study 3 reveals that the information various public-facing institutions circulate about potentially threatening environmental issues has the potential to induce stress for community members. Therefore, it is important to exercise caution when providing community members with information about things like emerging contaminants and historical contamination. Importantly, the social capital fact sheet may have buffered some of the negative effects of the threat of CEC. Together, these preliminary findings suggest that it may be possible to experimentally manipulate perceptions of social capital, that such manipulations may increase adaptive coping with environmental threats, and that further improving actual networks of social capital is a worthwhile avenue for future research and practice.

GENERAL DISCUSSION

Past literature suggests that the experience of living through CEC can cause considerable stress due to the uncertainty and chronic nature of its physical health and social impacts (Edelstein, 2018). Likewise, previous studies have shown that bonding, bridging, and linking social capital are important community resources that can be damaged by the onset of CEC, but that can also be sources of community resilience (Calloway et al., 2020; Couch & Coles, 2011). Across 3 studies with diverse methodologies, we have provided geographical, qualitative, and experimental support for the beneficial role of social capital in coping with CEC.

Study 1 offered an exploratory demonstration of the buffering role of social capital in the relationship between chronic exposure to environment hazards ($PM_{2.5}$) and mental distress. Study 2 took an in-depth look at the experiences of people who have lived through CEC, presenting various sources of stress faced by this community and highlighting how social capital has been leveraged to cope with this stress. Findings from Study 2 further suggest the importance of social

capital in not only coping with the stress experience of CEC, but also in driving positive change

by solidifying mutual trust and support between communities and institutions with the power to

implement change. Study 2 also revealed that rebuilding bonding, bridging, and linking social

capital after decades of lost trust, social conflict, and institutional delegitimization is a potentially

difficult process. These findings align with prior qualitative literature on the experience of CEC

(Sullivan et al., 2021). For instance, classic work by Kroll-Smith and Couch (1990) on the

impacts of CEC found that beyond physical health concerns, the *social* conflicts which arise

from the unique ambiguity and chronic nature of CEC can be just as disastrous.

    Study 3 provided an ecologically valid experimental demonstration of how perceptions of

social capital may facilitate adaptive responses to CEC. Specifically, when threatening

information about CEC was coupled with information about the presence and importance of

social capital in the local community, participants tended to report higher efficacy and engage in

less defensive denial of the threat of CEC. This study has important implications for

communicating the very real risks associated with CEC to the broader public in a way that does

not cause people to disengage from the issue. Exploratory analyses for Study 3 (Supplemental

Materials pp. S11-S14) provided preliminary evidence that increasing perceptions of social

capital in the face of the threat of CEC may be particularly impactful for racially/ethnically

minoritized individuals. This finding is particularly important in light of past literature showing

that communities of color and economically disadvantaged communities are more likely to

experience environmental contamination (Kramar et al., 2018), and that such communities face

worse mental and physical health outcomes from environmental exposures (Morello-Frosch &

Shenassa, 2006; Muhammad et al., 2018). The present study suggests that one way to combat

these disparities in the impacts of CEC is to strengthen (perceptions of) networks of social capital between impacted communities and institutions.

Limitations

A number of limitations warrant caution in interpreting findings from the present studies. The social capital indices used in Study 1 are limited in a few ways, as they are only proxies for bridging and linking social capital, and may not fit perfectly into other conceptualizations of these variables. Assessing social capital using a standardized set of variables across such diverse cultural, political, and socioeconomic climates as exist across all US counties risks essentializing social capital as a static and homogenous feature of a given community. However, as we have hopefully shown in Studies 2-3, perceptions and utilizations of social capital are also rooted in particular places with particular histories. Thus, if the indices of social capital used in Study 1 are limited because they risk over-generalization, we believe that our in-depth focus on the case study of CEC in Tucson's southside balances the broad with the specific.

The samples for Studies 2-3 were limited in their size and their representativeness of the Tucson population. The sample for Study 2 was primarily comprised of people who had already been intimately involved in environmental advocacy efforts, so responses likely reflected a greater degree of familiarity with CEC than is characteristic of the average person. The sample size for Study 3 was slightly underpowered to meaningfully detect certain effects. The target sample size was 212 participants, but after removing incomplete surveys and non-Tucson residents, the final sample size was somewhat smaller. The racial/ethnic diversity of this sample was not entirely representative of Tucson. When compared to the demographics of Tucson as a whole, the sample from Study 3 had proportionally twice as many white participants as there are in Tucson, and had proportionally half as many Latino or Hispanic participants. This suggests the

need for more targeted and intentional recruitment for future studies. The onset of COVID-19 and the resultant change in recruitment methods partway through conducting Study 3 may also limit the generalizability of findings.

Future Directions

Future qualitative and quantitative work should integrate theorizing on social capital into psychological investigations of responses to environmental threats. It is important for such work to adopt interdisciplinary theoretical lenses and mixed-methods approaches. By combining analyses of more distal social-structural with more proximal social psychological processes in the context of environmental issues, the field of psychology has the potential to make a positive impact in communities affected by CEC and other environmental injustice issues. Such investigations can be leveraged to create interventions and programs that facilitate positive interactions between impacted communities and institutions responsible for ensuring environmental safety. For instance, interventions targeting increases in social support and intracommunity harmony may improve bonding social capital, interventions targeting more typical environmental collective actions like participating in protests or attending meetings may improve bridging social capital, and interventions targeting community trust in institutions or effective communication from institutions may improve linking social capital. Each of these potential applications warrant their own future investigations, and may provide an avenue to integrate social identity models of environmental and collective action (Fritsche et al., 2018) into broader social scientific theorizing on social capital in these contexts.

For the field of psychology to meaningfully address collective environmental threats – from CEC, to global climate change – we recommend that beyond employing mixed-methods, the field should embrace participatory action research (PAR) paradigms (Israel et al., 1998;

Watkins, 2015). Such approaches can help to improve networks of social capital, to facilitate

fruitful community-academic relationships, to build community resilience, and to help impacted

communities envision a future beyond the uncertainty of a contaminated present.

CRediT Author Statement

Harrison J. Schmitt: Conceptualization, Methodology, Validation, Formal Analysis, Investigation, Writing – Original Draft, Writing – Review and Editing, Visualization, Project Administration. **Daniel Sullivan:** Conceptualization, Methodology, Validation, Investigation, Writing – Original Draft, Writing – Review and Editing, Supervision. **Alexis N. Goad:** Conceptualization, Writing – Review and Editing, Validation. **Roman Palitsky:** Conceptualization, Writing – Review and Editing, Validation.

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