5-2023

Discrimination and cognitive failures in Singapore and the US: An investigation of between- and within-persons associations through multilevel modelling

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Published in International Journal of Intercultural Relations (2023) 94, 101805. DOI: 10.1016/j.ijintrel.2023.101805

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Declaration of interest: None.

Funding: The research in Study 1 was supported by a grant awarded to Andree Hartanto by Singapore Management University through research grants from the Ministry of Education Academy Research Fund Tier 1 (21-SOSS-SMU-023) and Lee Kong Chian Fund for Research Excellence. The research in Study 2 was supported by the following: John D. and Catherine T. MacArthur Foundation Research Network; National Institute on Aging (P01-AG020166); National institute on Aging (U19-AG051426). The funders had no role in the analysis and interpretation of the data, writing of the report, and decision to submit the article for publication.

Abstract

Experiencing everyday discrimination can have a significant negative impact on an individual's wellbeing. While much attention has been paid to the physical and mental health consequences of discrimination, less is known about how discrimination can affect cognitive health, and most existing work has been conducted in laboratory settings where participants recall discrimination retrospectively. Given the artificial environment and susceptibility to recall bias in such procedures, the current study utilised two daily diary studies, consisting of young adults in Singapore (Study 1; *N*=484) and midlife adults from the US (Study 2; *N*=3577), to examine the association between discrimination and cognitive failures in daily life. Multilevel modelling revealed consistent evidence that experiencing discrimination was associated with poorer cognitive health at both the within- and between-person levels. These associations between discrimination and cognitive health remained robust even after controlling for demographic covariates previously found to affect cognitive health, as well as daily stressor exposure. These findings suggest that the experiences of everyday discrimination may lead to poorer daily cognitive functioning regardless of whether discrimination was experienced in a daily context or across the lifespan, and indicate importance of raising awareness on the harmful cognitive consequences of discrimination.

Keywords: Discrimination, cognitive failures, daily diary, multilevel modelling

Discrimination and Cognitive Failures in Singapore and the US

Everyday experiences with discrimination—bias that spills into daily attitudes and behaviours (Essed, 1991; Harrell, 2000) such as being treated with less courtesy than others (Williams et al., 1997)—can have negative acute and cumulative impacts on well-being (Pierce, 1995; Tougas et al., 2004; Volpe et al., 2019). Although it is commonly associated with race, everyday discrimination can include other aspects such as age, gender, sex, or sexual orientation (Mays & Cochran, 2001; Mouzon et al., 2020), and much of the existing literature has conceptualised everyday discrimination—regardless of what attribute it is in relation to—as a psychosocial risk factor for various negative outcomes (Banks et al., 2006). While the physical and mental health consequences of everyday discrimination have been relatively well-studied (e.g., Neblett et al., 2004; Ong, 2021; Sutin et al., 2015), the consequences of everyday discrimination on cognitive health have been relatively neglected.

Cognitive health can be assessed in various ways. Specifically, in relation to discrimination, research has examined its effects on memory (Barnes et al., 2012; Shankar & Hinds, 2017; Sutin et al., 2015; Zahodne et al., 2020), perceptual or processing speed (Barnes et al., 2012; Zahodne et al., 2020), verbal fluency (Shankar & Hinds, 2017), and executive functioning (Zahodne et al., 2020). Indeed, there are theoretical and empirical reasons to believe that stressful events—such as experiencing discrimination (Neblett et al., 2004)—can have detrimental ramifications for cognitive health (Bremner, 1999; Klein & Boals, 2001; Mahoney et al., 1998). Experiencing stress is thought to consume individuals' already-limited cognitive reserves, leaving less cognitive resources for the present moment (Smeekens & Kane, 2016). In line with this, Salvatore and Shelton (2007) found that exposure to racial prejudice was associated with cognitive costs in the form of greater interference when attempting to process information.

However, most existing studies examining the effects of discrimination on cognitive health examine this association under a controlled laboratory setting where participants are tasked to recall retrospectively. In reality, cognitive failures—the inability to perform routine or otherwise simple tasks that an individual is usually able to perform (Wallace, 2004)—are more applied to everyday experiences. Examples of cognitive failures with serious everyday implications include forgetting to take medication or failing to notice the red light when crossing the road. While some studies have examined the association between discrimination and cognitive failures (e.g., Barnes et al., 2012; Salvatore & Shelton, 2007), they were conducted in lab settings where experiences were recalled retrospectively. Therefore, the external validity of the existing literature is limited as existing studies are affected by the artificiality of their environments, on top of the issue of recall bias. Hence, a better way to assess the relationship between discrimination and cognitive failures is to use a daily diary methodology to minimise time lag, and hence recall bias (Hartanto et al., 2022).

Taken together, the goal of the current study is to examine the associations between everyday discrimination and cognitive failures at both within-person and between-person levels through utilising pre-existing datasets from two daily diary studies for seven (Study 1) or eight (Study 2) consecutive days. Tracking participants across a week was considered most

appropriate as the variables of interest were microlevel within-person processes such as daily discrimination and daily cognitive failures (Lischetzke, 2014).). As constructs such as daily cognitive failures are likely to occur relatively often, measuring once daily for a week is considered desirable and likely to yield a representative sample with multiple responses regarding the constructs of interest (Hektner et al., 2007). Additionally, measuring only for seven or eight days impose relatively little burden on the participants compared to longer data collection periods, thereby lessening the possibility of random responses or attrition (Conner & Lehman, 2011; Gunthert & Wenz, 2011). Indeed, existing research examining daily discrimination and daily cognitive failures have used a week as the measurement time period (Hartanto et al., 2022; Mallet & Swim, 2009; Ong et al., 2022). Study 1 aimed to examine whether baseline discrimination was associated with daily cognitive failures. Study 2 sought to further expand the results of Study 1 by examining the association between baseline discrimination and daily cognitive failures. Additionally, Study 2 also aimed to examine the association between daily discrimination and daily cognitive failures in order to disentangle the within- and between- person associations between daily discrimination and daily cognitive failures. The use of daily diary methodology would allow us to elucidate potential consequences of everyday discrimination on cognitive functioning in a naturalistic setting.

Transparency and Openness

The current work's design and its analysis plan were not pre-registered. Relevant materials and data for Study 1 have been made publicly available on Researchbox (#450; https://researchbox.org/450), while those for Study 2 are available from ICPSR (https://www.icpsr.umich.edu/). Analytic code, zero-order correlation matrices, a summary of the variables used in each Study, and more information on model fits for both studies are also available on Researchbox.

All analyses were conducted in *R* version 3.6.3 (R Core Team, 2020). Descriptives and single-level scale reliabilities were extracted using *psych* version 2.2.9 (Revelle, 2021). ICCs were calculated by *merTools* version 0.5.2 (Knowles & Frederick, 2020). Multilevel analyses, including calculation of multilevel reliabilities, were performed using *lme4* version 1.1-28 with *bobyqa* optimisation (Bates et al., 2014) and significance testing carried out by *lmerTest* version 3.1-3 (Kuznetsova et al., 2017). Effect sizes in the form of standardised coefficients and corresponding 95% CIs were computed using the *pseudo* method from *effectsize* version 0.6.0.1 (Ben-Shachar et al., 2020).

Study 1

Study 1 comprised two independent waves of a daily diary study conducted among undergraduates at Singapore universities, collected from June 2021 to August 2021 (wave 2; see Goh et al., 2023; Ng et al., 2022) and from July 2022 to September 2022 (wave 3; see Veerapandian et al., 2023).[1] At baseline, participants provided demographic and psychosocial data through two separate questionnaires taking a combined duration of 90 minutes. During

[1] Wave 1 did not include any data on discrimination and hence was not included in the current work.

the daily diary portion, participants responded to short self-administered questionnaires about their daily experiences across seven consecutive nights. All participants provided informed consent and data collection was approved by the Institutional Review Board at one of the involved universities.

Method

Participants

A total of 484 young adults from Singapore took part in both the baseline and the daily diary arms of the project. Participants were aged 18–30 (*M*=21.86, *SD*=1.83). Each participant provided an average of 6.75 days of observations (out of a maximum of 7 days per participant; 96% completion rate). Sample descriptive statistics are available in Table 1.

Table 1
Descriptive Statistics in Study 1

Variable	*M*	*SD*	Observed Range	Theoretical Range	ICC
Person Level ($N_{participants}$=484)					
Age	21.86	1.83	18–30		
Sex (% male)	26%				
Race (% Chinese)	77%				
Monthly household income	3.11	1.49	1–6	1–6	
Subjective social standing	6.11	1.30	2–10	1–10	
Baseline discrimination	1.84	0.52	1.00–3.33	1.00–4.00	
Average cognitive failures over 7 days	0.35	0.36	0.00–2.87	0.00–3.00	
Average stressor exposure over 7 days	.36	.27	.00–1.00	.00–1.00	
Day Level ($N_{observations}$=3266)					
Daily cognitive failures	0.35	0.45	0.00–3.00	0.00–3.00	.57
Daily stressor exposure (% stressor days)	37%				.58

Note. Monthly household income was measured on a six-point scale (1=*Less than 2,000 SGD*, 6=*More than 20,000 SGD*). Subjective social standing was measured on a 10-point scale (1=*lowest status*, 10=*highest status*; Adler et al., 2000).

Measures of Interest

Discrimination. The experience of discrimination in everyday life was measured at baseline through a nine-item scale developed by Williams et al. (1997). Participants were asked to indicate how often they experienced various situations (e.g., “I am treated with less courtesy than other people”, “People act as if they are afraid of me”, “I am threatened or

harassed") on a four-point scale (1=*Never*, 4=*Often*). Items were averaged to create an overall everyday discrimination score (α=.86).

Daily Cognitive Failures. The incidence of daily cognitive failures was measured during each day of the seven-day diary using a 13-item scale assessing cognitive failures in everyday life (Lange & Süß, 2014). Participants were asked to report how often they experienced various situations on a daily basis (e.g., "Did you leave a task unfinished due to distraction(s), at any point of time today?", "Did your mind feel overloaded because of having too much information, at any point of time today?", "Did you unintentionally say something twice, at any point of time today?") on a four-point scale (0=*Never*, 3=*Several times*). Items were averaged to create an overall daily cognitive failure score ($\alpha_{between}$=.90, α_{within}=.66)**.**

Daily Stressor Exposure. Exposure to daily stressors was measured using the 7-item Daily Inventory of Stressful Events (Almeida et al., 2002). Each day, participants were asked if any of seven types of stressors (arguments, avoided arguments, discrimination, work/education stressors, home stressors, network stressors, and "others") occurred to them since the previous day. Due to overlap with the discrimination focal predictor, we omitted the discrimination stressor item from the computation of daily stressor exposure in the current work. In line with existing work on this construct (e.g., Ng et al., 2022; Majeed et al., 2021; Rush et al., 2019), daily stressor exposure was operationalised as a binary variable. Specifically, if at least one stressor was experienced on that day, the day was categorised as a stressor day, and otherwise, it was categorised as a non-stressor day.

Analytic Plan

Due to the nested structure of the data where participants (Level 2) were observed across multiple days (Level 1), we conducted linear multilevel modelling to make full use of all available data. Specifically, we modelled daily cognitive failures as a function of participant-level discrimination, with covariates added in addition models in order to examine the robustness of this association. Day was included as a random covariate in all models to account for potential effects of time, and the intercept (i.e., "baseline" value of daily cognitive failures) was also allowed to vary randomly across all participants.

First, we ran an unadjusted model (Model 1) to ensure that any observed associations between daily cognitive failures and participant-level discrimination were not contingent on other variables. The model was thus as shown in the following equations, where γ_{01} is the between-persons parameter of interest:

Level 1: $(\text{Daily cognitive failures})_{di}=B_{0i}+B_{1i}(\text{day})_{di}+\varepsilon_{di}$

Level 2: $B_{0i}=\gamma_{00}+\gamma_{01}(\text{discrimination})_{i}+\mu_{0i}$

$B_{1i}=\gamma_{10}+\mu_{1i}$

Second, we adjusted for demographic covariates—specifically age, sex, race, income, and subjective social standing—that previous research has found to influence cognitive health (Banks et al., 2014; Hyde, 2016; Murman, 2015; Tomasi & Volkow, 2021) in an initial adjusted model (Model 2). Third, to examine whether discrimination was associated with cognitive failures above and beyond the influence of exposure to other daily stressors, we additionally adjusted for daily stressor exposure (Neupert et al., 2006) by including dummy-coded daily stressor exposure (0 = *non-stressor day*, 1 = *stressor day*) as a random covariate at the day level, and average daily stressor exposure (derived by computing the number of days which were stressor days for each participant) as a fixed covariate at the participant level (Model 3) in order to properly de-bias the between-person estimate of γ_{01} (for similar approach, see Ng et al., 2022; Majeed et al., 2021; for further details, see Bolger et al., 2012; Enders & Tofhigi, 2007). The final adjusted model was thus as shown in the following equations, where γ_{01} is the between-persons parameter of interest:

Level 1: $(\text{Daily cognitive failures})_{di}=B_{0i}+B_{1i}(\text{day})_{di}+B_{2i}(\text{daily stressor exposure})_{di}+\varepsilon_{di}$

Level 2: $B_{0i}=\gamma_{00}+\gamma_{01}(\text{discrimination})_i+\gamma_{02}(\text{age})_i+\gamma_{03}(\text{sex})_i+\gamma_{04}(\text{race})_i$
$+\gamma_{05}(\text{income})_i+\gamma_{06}(\text{subjective social standing})_i$
$+\gamma_{07}(\text{average daily stressor exposure})_i+\mu_{0i}$

$B_{1i}=\gamma_{10}+\mu_{1i}$

$B_{2i}=\gamma_{20}+\mu_{2i}$

Results

We found that, from the 484 participants (3266 observations), discrimination at baseline was significantly associated with daily cognitive failures to a small extent (unadjusted and adjusted for demographics: β=.17, 95% CI=[.08, .27], γ_{01}=0.11, *SE*=0.03, $p<.001$; additionally adjusted for daily stressor exposure: β=.11, 95% CI=[.04, .19], γ_{01}=0.07, *SE*=0.03, p=.005). Specifically, participants who reported experiencing more discrimination at baseline had more daily cognitive failures than did participants who reported experiencing less discrimination at baseline, regardless of demographic factors, and above and beyond exposure to other stressors. Full details are available in Table A1.

Study 2

To expand on the results of Study 1, Study 2 was conducted utilising data from the baseline (Ryff et al., 2016) and daily diary (Ryff & Almeida, 2018) arms of the MIDUS Refresher project. At baseline (collected between November 2011 and September 2014), participants provided demographic and psychosocial data through a 30-minute phone interview followed by two 50-page mailed self-administered questionnaires. During the daily diary portion (collected between October 2012 and November 2014), participants responded to short telephone interviews about their daily experiences across eight consecutive days. All participants provided informed consent and data collection was approved by the Institutional Review Board at the University of Wisconsin-Madison.

Method

Participants

A total of 3,577 adult participants in the US took part in the baseline arm of the project, of whom 782 took part in the daily diary arm of the project and thus had data available for analysis. However, 38 participants were excluded from the current analysis due to missing demographic data, leaving 744 participants aged 25–75 (*M*=47.79, *SD*=12.68). Each participant provided an average of 7.49 days of observations (94% completion rate). Sample descriptive statistics are available in Table 2.

Table 2
Descriptive Statistics in Study 2

Variable	*M*	*SD*	Observed Range	Theoretical Range	ICC
Person Level ($N_{participants}$=744)					
Age	47.79	12.68	25–75		
Sex (% male)	45%				
Race (% White)	85%				
Marital status (% married)	66%				
Annual personal income (in thousands)	50.91	49.81	0–300		
Highest education	8.03	2.43	3–12	1–12	
Subjective social standing	6.14	1.91	1–10	1–10	
Baseline discrimination [a]	1.48	0.54	1.00–3.67	1.00–4.00	
Average discrimination over 8 days	0.15	0.47	0.00–6.00	0.00–9.00	
Average cognitive failures over 8 days	0.77	0.91	0.00–7.00	0.00–9.00	
Average stressor exposure over 8 days	.42	.27	.00–1.00	.00–1.00	
Day Level ($N_{observations}$=5571)					
Daily discrimination	0.14	0.64	0–8	0–9	.33
Daily cognitive failures	0.73	1.14	0–8	0–9	.45
Daily stressor exposure (% stressor days)	41%				.46

Note. Highest education was measured on a 12-point scale (1=*No school/some grade school*, 12=*PhD, EdD, MD, DDS, LLB, LLD, JD, or other professional degree*). Subjective social standing was measured on a 10-point scale (1=*lowest status*, 10=*highest status*; Adler et al., 2000). [a] Six participants declined to provide information on discrimination at baseline.

Measures of Interest

Discrimination. The experience of discrimination in everyday life was measured at baseline through the same nine-item scale as in Study 1 (Williams et al., 1997; α=.92). In addition, during each day of the eight-day diary, participants were asked to indicate whether each of the same nine situations happened to them that day (0=*No*, 1=*Yes*). Items were summed to create an overall daily discrimination score per day ($\alpha_{between}$=.36, α_{within}=.99).

Daily Cognitive Failures. The incidence of daily cognitive failures was measured during each day of the eight-day diary using a nine-item scale assessing everyday memory failures (Sunderland et al., 1983). Participants were asked to report whether they had experienced forgetfulness (0=*No*, 1=*Yes*) in the past 24 hours in terms of specific contexts (e.g., "forget to do an errand or chore", "forget why you entered a room", "forget someone's name"). Items were summed to create an overall daily cognitive failure score ($\alpha_{between}$=.94, α_{within}=.35).

Daily Stressor Exposure. Each participant's exposure to stressors per day was assessed with the same measure as in Study 1.

Analytic Plan

We first ran unadjusted (Model 1) and adjusted analyses (Model 2 and Model 3) similar to Study 1 using baseline discrimination and daily cognitive failures, with two modifications. First, as the measure of daily cognitive failures in Study 2 was a count variable, we used Poisson multilevel modelling rather than linear multilevel modelling. Second, due to the nature of the sample in Study 2 (i.e., adults spanning a wide age range and of various demographic profiles), we included two additional demographic covariates (marital status and highest education) in the initial adjusted model. As such, the equations for the final adjusted model are as follows, where γ_{01} is the between-persons parameter of interest:

Level 1: $\log(\text{Daily cognitive failures})_{di} = B_{0i} + B_{1i}(\text{day})_{di} + B_{2i}(\text{daily stressor exposure})_{di} + \varepsilon_{di}$

Level 2:
$$B_{0i} = \gamma_{00} + \gamma_{01}(\text{discrimination})_i + \gamma_{02}(\text{age})_i + \gamma_{03}(\text{sex})_i + \gamma_{04}(\text{race})_i + \gamma_{05}(\text{marital status})_i + \gamma_{06}(\text{income})_i + \gamma_{07}(\text{education})_i + \gamma_{08}(\text{subjective social standing})_i + \gamma_{09}(\text{average daily stressor exposure})_i + \mu_{0i}$$

$$B_{1i} = \gamma_{10} + \mu_{1i}$$

$$B_{2i} = \gamma_{20} + \mu_{2i}$$

Then, we conducted a separate set of multilevel analyses to disentangle the within-person (Level 1) and between-persons (Level 2) associations between daily discrimination and daily cognitive failures, both in an unadjusted model (Model 1) and two adjusted models (Model 2 and Model 3) with the same covariates as previously mentioned. To do this, daily

discrimination was person-mean centred at Level 1 and each participant's average discrimination over the 8 days was reintroduced at Level 2 (Bolger et al., 2012; Enders & Tofhigi, 2007), in parallel to what was done for daily stressor exposure in both studies. Importantly, we included a random slope component, such that we allowed the association between daily discrimination and daily cognitive failures to vary across participants. The adjusted model was thus as shown in the following equations,[2] where γ_{01} and γ_{10} are the between-persons and within-person parameters of interest respectively:

Level 1: $\log(\text{Daily cognitive failures})_{di}=B_{0i}+B_{1i}(\text{daily discrimination})_{di}+B_{2i}(\text{day})_{di}+B_{3i}(\text{daily stressor exposure})_{di}+\varepsilon_{di}$

Level 2: $B_{0i}=\gamma_{00}+\gamma_{01}(\text{average daily discrimination})_i+\gamma_{02}(\text{age})_i+\gamma_{03}(\text{sex})_i+\gamma_{04}(\text{race})_i+\gamma_{05}(\text{marital status})_i+\gamma_{06}(\text{income})_i+\gamma_{07}(\text{education})_i+\gamma_{08}(\text{subjective social standing})_i+\gamma_{09}(\text{average daily stressor exposure})_i+\mu_{0i}$

$B_{1i}=\gamma_{10}+\mu_{1i}$

$B_{2i}=\gamma_{20}+\mu_{2i}$

$B_{3i}=\gamma_{30}+\mu_{3i}$

Results

Baseline Discrimination

We found that, from the 738 participants (5533 observations) with available data, discrimination at baseline was significantly associated with daily cognitive failures to a small extent (unadjusted: β=.19, 95% CI=[.12, .27], γ_{01}=0.36, *SE*=0.07, p<.001; adjusted for demographics: β=.20, 95% CI=[.13, .28], γ_{01}=0.38, *SE*=0.07, p<.001; additionally adjusted for daily stressor exposure: β=.15, 95% CI=[.08, .22], γ_{01}=0.28, *SE*=0.07, p<.001). Specifically, participants who reported experiencing more discrimination at baseline had more daily cognitive failures than did participants who reported experiencing less discrimination at baseline, regardless of demographic factors and above and beyond daily stressor exposure, consistent with findings from Study 1. Full details are available in Table A2.

Daily Discrimination

We similarly found that, from the 744 participants (5571 observations) with available data on daily discrimination, discrimination was significantly associated with daily cognitive failures to a moderate extent at the between-persons level (unadjusted: β=.20, 95% CI=[.14, .26], γ_{01}=0.43, *SE*=0.06, p<.001; adjusted for demographics: β=.22, 95% CI=[.16, .28],

[2] Although the daily discrimination models achieved singular fit using the specified terms, all terms were retained as the model was theoretically-informed and it would not have been theoretically accurate to drop any of the random effects.

γ_{01}=0.47, *SE*=0.06, *p*<.001; additionally adjusted for daily stressor exposure: β=.12, 95% CI=[.07, .17], γ_{01}=0.26, *SE*=0.05, *p*<.001) and to a small extent at the within-person level (unadjusted: β=.07, 95% CI=[.04, .10], γ_{10}=0.14, *SE*=0.03, *p*<.001; adjusted for demographics: β=.07, 95% CI=[.03, .10], γ_{10}=0.13, *SE*=0.03, *p*<.001; additionally adjusted for daily stressor exposure: β=.04, 95% CI=[.01, .07], γ_{10}=0.09, *SE*=0.03, *p*=.007). Specifically, it was not only that participants who experienced more daily discrimination (compared to participants who experienced less daily discrimination) reported more daily cognitive failures; importantly, participants experienced more cognitive failures on days they experienced more discrimination (compared to their own average levels of exposure to discrimination), though the magnitude of this relationship was larger at the between-persons level than at the within-persons level. Again, these results were consistently observed after controlling for demographic factors and daily stressor exposure. Full details are available in Table A3.

Discussion

Using data from a daily diary study of 253 young adults in Singapore across 7 days (Study 1) as well as 744 adults in the US across 8 days (Study 2), the current work found consistent evidence that discrimination was associated with poorer cognitive health both at the within-person and between-persons levels. Importantly, the positive associations between discrimination and cognitive failures remained significant even after controlling for demographic covariates previously found to influence cognitive health (Banks et al., 2014; Hyde, 2016; Murman, 2015; Tomasi & Volkow, 2021). Similar patterns were observed regardless of whether discrimination was operationalised as lifetime extent (i.e., average exposure to discrimination across the whole lifespan) or through daily checklists (i.e., day-to-day exposure to discrimination). Taken together, the current findings provide strong support for the hypothesis that higher levels of discrimination are associated with greater cognitive failure, regardless of whether the association was examined between or within individuals. Furthermore, the findings of our research suggest that the impact of discrimination on cognition is not merely limited to older individuals (e.g., Barnes et al., 2012). Indeed, we found a positive association between daily discriminatory experiences and daily cognitive failure among young adults (Study 1) as well as across adulthood (Study 2).

The current study distinguishes itself from previous work by examining the relationship between discrimination and cognitive health using a daily diary approach. Unlike previous works that were mainly conducted in controlled conditions where discrimination was recalled retrospectively in an artificial laboratory environment (Barnes et al., 2012; Salvatore & Shelton, 2007), the current study's daily diary approach allowed participants to recall experiences within a 24-hour time span, thereby addressing the limitation of a time lag (Conway & Briner, 2002), and also allowed for a more natural real-life setting. Indeed, existing research has shown that data quality decreases as recall time increases (te Braak et al., 2023), even for experiences such as discrimination (Potter et al., 2019) and memory failures (Joslyn et al., 2001), thereby highlighting the importance of shortening recall times. Furthermore, in cognitive studies, much research suggests that factors such as differences in

familiarity with cognitive task stimuli can greatly influence cognitive performance between participants (e.g., Poppenk et al., 2010), thereby evidencing the importance of ecological validity in examining cognitive outcomes. The resulting lack of recall bias (Stone & Shiffman, 2002) and higher ecological validity therefore strengthens both the internal and external validity of the current results and expands upon the work of previous studies on discrimination and cognitive health. Additionally, by examining daily cognitive health, the current study uncovered evidence that discrimination affects cognitive health not just in terms of major chronic issues—such as cognitive decline, cognitive impairment, and dementia (Barnes et al., 2012; Moody et al., 2019; Wang et al., 2022)—but also in terms of day-to-day seemingly mundane matters like cognitive failures. These findings highlight a vital concern given that cognitive failures in daily life, such as misplacing keys or failure to notice a red light while crossing the road, can have disastrous consequences ranging from poorer academic or job performance to even critical life-threatening accidents (Sadeghi et al, 2013; Wallace & Vodanovich, 2003).

Furthermore, the current work is the first to empirically disentangle the between-persons and within-person associations between discrimination and cognitive failure. While existing research has provided strong evidence that discrimination is associated with poorer cognitive health at a between-persons level (i.e., individuals who face greater discrimination have poorer cognitive health; e.g., Zahodne et al., 2020), the current work expands on these previous findings and provides the first empirical evidence that daily discrimination is associated with poorer daily cognitive functioning. Through the use of a daily dairy design, the findings of the current study rules out stable individual differences that may explain this negative association, lending greater confidence to the current findings.

Nonetheless, there are limitations of the current study that should be addressed. First, the participants of the current study consisted of relatively educated individuals (university undergraduates in Study 1, and individuals who completed at least 8th grade in Study 2). Given that education level has been suggested to buffer against factors that may affect cognitive health such as psychological distress (Zhang & Hong, 2013), it would be important to replicate the current findings among individuals with lower levels of formal education.

Second, the current study examined self-reported daily cognitive failures. Although examining cognitive failures on a daily basis helps to minimise recall biases compared to examining cognitive failures over a longer period of time (Conway & Briner, 2002), future studies may consider utilising both self- and other-reports to reduce possible biases associated with self-reports. It would be worthwhile to examine whether the current findings will be generalisable to other operationalisations of daily cognitive health as well, such as day-to-day processing speed.

Third, the non-experimental nature of the study is unable to establish causal relationships between discrimination and cognitive failures. While much of previous literature has suggested that discrimination leads to poorer cognitive health, the current study is unable to rule out the possibility that daily cognitive failures may lead to individuals perceiving themselves as having more experiences with discrimination. Additionally,

experimental studies may be able to control for any possible recency effect that may explain the current findings. By manipulating discrimination experiences in a controlled setting, future work may examine if the negative relationship between discrimination and cognitive health still hold true even after controlling for the recency of the discriminatory experience.

Finally, despite that fact that these studies were based in countries with relatively diverse ethnic backgrounds, we were unable to explore the effect of racial and ethnic discrimination on cognitive failures as the utilized datasets did not include enough participants from each minority races to split into individual races to conduct the required analysis . As racial and ethnic discrimination is considered to be a large facet of general discrimination (Krieger, 2000; Vargas et al., 2020), it is important for future studies to consider controlling for race or ethnicity to limit possible confounding effect and elucidate the effects of other specific types of discrimination.

Despite the limitations highlighted, the high-powered daily diary studies utilised in the present work lend strong support for the current hypothesis that discriminatory experiences would result in greater cognitive failures at both the between- and within-person levels. Although the nature of the current study did not allow for an experimental design, the present work was able to examine cognitive failures in a naturalistic and hence ecologically valid setting, contrary to most studies which examine cognitive health through laboratory testing in environments that are less reflective of what one experiences in everyday life (Spooner & Pachana, 2006).

Taken together, the current work suggests that experiences of everyday discrimination may lead to poorer daily cognitive functioning, thus emphasizing the need to educate individuals on the harmful effects of discrimination. While there is indeed greater awareness regarding the negative effects of discrimination on well-being today (e.g., Adams, 2021; Lewsley, 2020), the current work evidencing the association between discrimination and cognitive health further highlights the importance and urgency of raising awareness about discrimination in society, especially forms of discrimination that are not often discussed. Specifically, given that the current findings suggest that discrimination of all forms may harbour such negative implications on cognitive health, the present work suggests that we need to encourage greater discussions on discrimination of various forms and acknowledge that all types of discrimination experiences can implicate one’s daily functioning.

Since it is likely impossible to completely eradicate discrimination within society, these findings also call for greater research into potential risk and protective factors that can influence the relationship between discriminatory experiences and cognitive health. For instance, prior research indicates that stigma consciousness or a sense of community buffers against the effects of discrimination on well-being (e.g., Douglass et al., 2017; García-Cid et al., 2020). Given the importance of supporting victims of discrimination, it would be worthwhile to examine if this moderating role extends to buffering the cognitive impairment of daily discrimination.

Table A1

Summary of Multilevel Models Predicting Daily Cognitive Failures for Study 1

Predictor	Model 1					Model 2					Model 3				
	Std Est.	95% CI	Est.	*SE*	*p*	Std Est.	95% CI	Est.	*SE*	*p*	Std Est.	95% CI	Est.	*SE*	*p*
Fixed Effects															
Intercept γ_{00}	.00	[.00, .00]	0.24	0.06	<.001	.00	[.00, .00]	0.19	0.07	.006	.00	[.00, .00]	0.07	0.06	.203
Within-subject															
Day γ_{10}	-.16	[-.20, -.11]	-0.02	0.00	<.001	-.16	[-.20, -.11]	-0.02	0.00	<.001	-.13	[-.17, -.08]	-0.02	0.00	<.001
Daily stressor exposure γ_{20}											.18	[.14, .23]	0.11	0.01	<.001
Between-subject															
Baseline discrimination γ_{01}	.17	[.08, .27]	0.11	0.03	<.001	.17	[.08, .27]	0.11	0.03	<.001	.11	[.04, .19]	0.07	0.03	.005
Age γ_{02}						.01	[-.09, .11]	0.02	0.10	.823	.00	[-.08, .09]	0.01	0.08	.914
Sex γ_{03}						.11	[.01, .21]	0.09	0.04	.036	.06	[-.03, .14]	0.04	0.03	.200
Race γ_{04}						-.05	[-.14, .05]	-0.04	0.04	.331	-.03	[-.11, .04]	-0.03	0.03	.403
Monthly household income γ_{05}						-.01	[-.11, .09]	0.00	0.01	.884	-.01	[-.10, .07]	0.00	0.01	.760
Subjective social standing γ_{06}						-.07	[-.17, .03]	-0.02	0.01	.174	-.06	[-.15, .02]	-0.02	0.01	<.001
Average stressor exposure γ_{07}											.34	[.26, .42]	0.43	0.05	<.001
Random Effects															
Intercept μ_{0i}			0.17						0.16				0.10		
Day μ_{1i}			0.00						0.00				0.00		
Daily stressor exposure μ_{2i}													0.02		
Residual ε_{di}			0.07						0.07				0.07		

Note. $N_{\text{participants}}$=484, $N_{\text{observations}}$=3266. Std. Est. and 95% CI refer to the standardised estimate and its respective 95% confidence interval. Est. and *SE* refer to the estimate and its respective standard error. Estimates for random effects are given in the form of variances.

Table A2

Summary of Multilevel Models for Baseline Discrimination Predicting Daily Cognitive Failures for Study 2

Predictor	Model 1					Model 2					Model 3				
	Std Est.	95% CI	Est.	*SE*	*p*	Std Est.	95% CI	Est.	*SE*	*p*	Std Est.	95% CI	Est.	*SE*	*p*
Fixed Effects															
Intercept γ_{00}	.00	[.00, .00]	-0.64	0.12	<.001	.00	[.00, .00]	-0.77	0.13	<.001	.00	[.00, .00]	-1.57	0.13	<.001
Within-subject															
Day γ_{10}	-.16	[-.20, -.11]	-0.16	0.01	<.001	-.37	[-.42, -.31]	-0.16	0.01	<.001	-.27	[-.32, -.22]	-0.12	0.01	<.001
Daily stressor exposure γ_{20}											.18	[.12, .24]	0.38	0.06	<.001
Between-subject															
Baseline discrimination γ_{01}	.19	[.43, .32]	0.36	0.07	<.001	.20	[.13, .28]	0.38	0.07	<.001	.15	[.08, .22]	0.28	0.07	<.001
Age γ_{02}						-.02	[-.10, .06]	-0.04	0.08	.601	.01	[,06, .08]	0.01	0.03	.839
Sex γ_{03}						.11	[.03, .19]	0.23	0.08	.005	.09	[.02, .17]	0.19	0.07	.010
Race γ_{04}						-.07	[-.15, .01]	-0.20	0.11	.082	-.01	[-.08, .97]	-0.02	0.10	.865
Marital status γ_{05}						-.02	[-.10, .06]	-0.04	0.08	.601	-.02	[-.09, .95]	-0.04	0.08	.596
Monthly household income γ_{06}						.04	[-.04, .12]	0.08	0.09	.345	.05	[-.03, .12]	0.09	0.08	.244
Education γ_{07}						.07	[-.02, .15]	0.03	0.02	.124	.03	[-.05, .10]	0.01	0.02	.519
Subjective social standing γ_{08}						.04	[-.04, .12]	0.08	0.09	.345	.-.01	[-.08, .06]	-0.01	0.02	.519
Average stressor exposure γ_{09}											.39	[.31, .46]	1.44	0.14	<.001
Random Effects															
Intercept μ_{0i}			0.47					0.48					0.61		
Day μ_{1i}			0.01					0.01					0.01		
Daily stressor exposure μ_{2i}													0.10		

Note. $N_{\text{participants}}$=738, $N_{\text{observations}}$=5533. Std. Est. and 95% CI refer to the standardised estimate and its respective 95% confidence interval. Est. and *SE* refer to the estimate and its respective standard error. Estimates for random effects are given in the form of variances.

Table A3

Summary of Multilevel Models for Daily Discrimination Predicting Daily Cognitive Failures for Study 2

Predictor	Model 1					Model 2					Model 3				
	Std Est.	95% CI	Est.	*SE*	*p*	Std Est.	95% CI	Est.	*SE*	*p*	Std Est.	95% CI	Est.	*SE*	*p*
Fixed Effects															
Intercept γ_{00}	.00	[.00, .00]	-0.21	0.05	<.001	.00	[.00, .00]	-0.34	0.07	<.001	.00	[.00, .00]	-0.69	0.08	<.001
Within-subject															
Daily discrimination γ_{10}	.07	[.04, .10]	0.14	0.03	<.001	.07	[.03, .10]	0.13	0.03	<.001	.04	[.01, .07]	0.09	0.03	.007
Day γ_{20}	-.35	[-.40, -.29]	-0.15	0.01	<.001	-.34	[-.39, -.29]	-0.15	0.01	<.001	-.44	[-.49, -.38]	-0.19	0.01	<.001
Daily stressor exposure γ_{30}											.03	[-.01, .08]	0.07	0.05	.165
Between-subject															
Average discrimination γ_{01}	.20	[.14, .26]	-0.15	0.01	<.001	.22	[.16, .28]	0.47	0.06	<.001	.12	[.07, .17]	0,26	0l05	<.001
Age γ_{02}						-.06	[-.14, .01]	-0.05	0.03	.092	.01	[-.05, .07]	0.01	0.02	.755
Sex γ_{03}						.13	[.06, .21]	0l26	0.08	.001	.01	[.05, .16]	0.21	0.06	<.001
Race γ_{04}						-.03	[-.10, .04]	-0.07	0.11	.484	.02	[-.03, .08]	0l06	0l08	.426
Marital status γ_{05}						-.02	[-.10, .05]	-0.05	0.08	.567	-.01	[-.07, .04]	-0.03	0.06	.644
Monthly household income γ_{06}						.03	[-.05, .11]	0.06	0.08	.434	.04	[-.02, .10]	0.09	0.06	.150
Education γ_{07}						.07	[-.01, .15]	0.03	0.02	.106	.01	[-.06, .07]	0.00	0.01	.870
Subjective social standing γ_{08}						-.02	[-.09, .06]	-0.01	0.02	.685	-.03	[-.08, .03]	-0.01	0.02	.332
Average stressor exposure γ_{09}											.35	[.28, .41]	1.29	0.12	<.001
Random Effects															
Intercept μ_{0i}			0.40					0.39					0.00		
Daily discrimination μ_{1i}			0.01					0.01					0.01		
Day μ_{2i}			0.01					0.01					0.02		
Daily stressor exposure μ_{3i}													0.12		

Note. $N_{\text{participants}}$=744, $N_{\text{observations}}$=5571. Std. Est. and 95% CI refer to the standardised estimate and its respective 95% confidence interval. Est. and *SE* refer to the estimate and its respective standard error. Estimates for random effects are given in the form of variances.

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