

INVESTIGATING THE EFFECTS OF DISCRIMINATION
EXPERIENCES ON EVERYDAY
METAMEMORY

by

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ABSTRACT

Lifetime and daily experiences of discrimination (based on race, gender, religion, and sexual orientation) contribute to impaired performance on cognitive assessments. However, the underlying mechanism by which discrimination negatively impacts cognition is unclear. Recent research investigating stress-induced impairment of metamemory may address the relationship between discrimination experiences and cognitive impairment. The aim of this study was to determine the relationship between lifetime and daily experiences of discrimination, daily affect balance, baseline objective cognitive performance, and sociodemographic variables (age, race, ethnicity, and sex assigned at birth) on impaired everyday metamemory as defined by the number of subjective cognitive complaints from a lifespan perspective (ages 20-75), using data collected from the Midlife in the United States (MIDUS Refresher 1) Daily Diary Project (N = 782). Results from linear mixed model analyses showed significant within-person fixed effects of daily discrimination and daily affect balance on metamemory accuracy, as well as significant between-persons fixed effects of race, and ethnicity on metamemory accuracy. Furthermore, significant interaction effects were found between race and daily discrimination experiences, ethnicity and daily discrimination experiences, daily affect balance and daily discrimination experiences, daily affect balance and age, and endorsement of lifetime experiences of discrimination and daily discrimination experiences on day-to-day metamemory accuracy. These findings add to our understanding of how psychosocial stress may impair metacognitive processes and demonstrate the need for more research into understanding metamemory accuracy

as an underlying mechanism by which the psychosocial stressor of discrimination impacts cognition across the lifespan.

LIST OF ABBREVIATIONS AND SYMBOLS

α	Cronbach's alpha: a coefficient of internal consistency
b	Unstandardized beta coefficient
CI	Confidence Interval
M	Mean: the sum of a set of measurements divided by the number of measurements
N	Total sample size
n	Subset of total sample size
p	Probability associated with the occurrence under the null hypothesis of a value
r	Pearson product-moment correlation
SD	Standard deviation
SE	Standard Error
>	Greater than
<	Less than
=	Equal to

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INTRODUCTION

Subjective cognitive decline (SCD) is a growing public health issue with a prevalence rate of 1 in 9 adults ages 45 years and older, according to the Center for Disease Control (CDC, 2019). SCD is the self-perceived decline in cognitive functioning in the absence of decline in objective cognitive performance (Jessen et al., 2014, Reisberg et al., 2008, Tandetnik et al., 2015). In recent years, SCD, more specifically subjective memory impairment (SMI), has garnered interests as a promising predictor of pre-clinical Alzheimer's disease (AD) (Jessen et al., 2010, Jessen et al., 2014, Johansson, Allen-Burge, & Zarit, 1997, Reisberg et al., 2008, Studart, & Nitrini, 2016). The premise is that individuals with intact self-awareness and self-reflection, otherwise known as metacognition, will become aware of changes in their memory and cognitive performance prior to other indicators.

Metamemory and Metacognitive Knowledge Accuracy

Metacognition is the process of thinking of one's own thoughts and involves the monitoring and control of one's cognitions (Flavell, 1976). An individual's metacognition related to memory is known as metamemory (Nelson, 1990). Specific to the interests of subjective memory impairment is the metacognitive sub-component of metacognitive knowledge, which is defined as an individual's knowledge and understanding of their own and other people's cognitive abilities (Flavell, 1979). Moreover, the accuracy of an individual's metamemory is associated with the extent to which their subjective cognitive decline maps onto their objective cognitive performance (Chapman et al., 2022). Whereas metamemory is

predictive of subjective cognitive decline, metamemory is not associated with objective cognitive performance (Li et al., 2022). Rather, metamemory accuracy mediates the discrepancy between subjective cognitive complaints and normative objective cognitive performance, where greater metamemory accuracy may compensate for objective cognitive deficits (Giffard et al., 2020). Metacognitive knowledge as a whole can be conceptualized as an individual's capacity to determine if they have the resources necessary for accomplishing a task. This knowledge is pertinent to an individual's engagement in effective coping strategies in response to emotional distress (Fisher and Wells, 2008; Wells, 1996).

Stress

Emotional distress emerges when an individual is exposed to a stressor. Lazarus and Folkman (1984) initially conceptualized the transactional theory of stress and coping, which posits that psychological stress is the product of interactions between an individual and their environment, involving cognitive appraisals of the threat and the adoption of coping strategies. Appraisals can be seen as thoughts or cognitions, such that primary appraisals are primary cognitions and secondary appraisals are thoughts assessing the primary cognitions making secondary appraisals or cognitions metacognitive in nature (Rucker, Turnes, & Petty, 2011). Coping refers to cognitive and behavioral strategies utilized by the individual in response to psychological stress (Folkman & Lazarus, 1985). More importantly, the coping strategy employed will result in adaptive or maladaptive biopsychosocial outcomes (Spada et al., 2008).

Discrimination as a stressor

Discrimination has been identified as a chronic psychosocial stressor contributing to disparities in acute and long-term mental, physical, and cognitive health outcomes. Research efforts have largely focused on the implications of racism and ethnic discrimination on mental

and physical health outcomes, such that exposure to racism and ethnic discrimination was associated with poorer mental health, poorer physical health, and poorer general health of targeted individuals (Brandolo et al., 2011; Chen and Mallory, 2021; Harrell, Hall, and Taliaferro, 2003; Harrell et al., 2011). Furthermore, exposure to discrimination and prospective anticipation of discrimination lead to psychological and physiological stress responses (Sawyer et al., 2012).

Berjot and Gillet (2011) expanded upon Lazarus and Folkman's theory by considering the effect of stigma in the transactional model of stress and coping, such that the appraisal of a discrimination experience differentially alters the selection of coping strategies that may result in acute and chronic outcomes. In an experimental study of perceived discrimination and affective responses to ambiguous interpersonal interactions among African American men, Bennet and colleagues (2004) found that perceived discrimination in ambiguous situations generated greater negative affect reactivity compared to individuals that did not perceive discrimination.

More recent research has focused on the impact of discrimination on cognitive health outcomes. Like research on physical and mental health outcomes, research on stress and cognition has been dedicated towards understanding the impact of racial and ethnic discrimination on cognitive health disparities. Studies have shown how experiences of perceived racism and discrimination negatively influence specific cognitive domains (Barnes et al., 2012; Sutin et al., 2015) and subjective cognitive decline (Coogan et al., 2020). Furthermore, a study examining everyday discrimination and subsequent cognitive abilities found broad and enduring effects of discrimination on cognitive aging, especially executive functioning and visuoconstruction (Zahodne et al., 2020). In a broader study comparing the influence of lifetime and recent experiences of discrimination on executive functioning, Keating and colleagues (2021) found

that recent discrimination experiences were negatively associated with two core executive functions: cognitive flexibility and working memory. Overall, however, findings on the impact of discrimination on cognitive health outcomes have been inconsistent and are influenced by differences in cognitive outcome measurement, measurement of discrimination experiences, and sample representation (Meza et al., 2022).

Stress and Metamemory

Several studies have sought to investigate the relationship between stress and metamemory. In a study investigating the influence of psychosocial stress on metacognitive accuracy, Reyes and colleagues (2015) found that high biological reactivity to psychosocial stress correlated with impaired metacognitive accuracy. Furthermore, Reyes and colleagues (2020) noted that metacognitive efficiency decreased upon hydrocortisone injection above and beyond the effects of perceived psychosocial stress. In addition to biological reactivity, emotional and psychological distress (such as depression symptomatology) have been shown to be positively associated with subjective memory complaints, indicating a link between negative affect and impaired metamemory (Tomita et al., 2014; Seo et al., 2017). Much remains unknown, however, regarding the mechanism by which stress affects metacognition, particularly metamemory.

Rationale and Study Objectives

Although some studies have sought to understand the relationship between stress and metacognition (Langer et al., 2020; Reyes et al., 2015, 2020; Spada et al., 2008), there are few studies seeking to understanding the implications of discrimination (as a specific stressor) on metacognition and, more specifically, metamemory. The present study is a secondary data analysis of the Midlife in the United States Refresher epidemiological dataset (MIDUS

Refresher; 2011-2014), the MIDUS Refresher Cognitive Project (MIDUS R-Cog; 2011-2014), and the MIDUS Refresher Daily Diary Project (MIDUS R-DD; 2012-2014). Collected between 2011 and 2014, the MIDUS Refresher Study sought to examine the interplay of key factors, such as socioeconomic status, gender, psychosocial factors, and biological factors, in mid- and later life health through phone interviews and self-administered questionnaires. The Cognitive Project sought to assess for objective cognitive functioning in the domains of episodic verbal memory, working memory, verbal fluency, processing speed, executive functioning, fluid intelligence, and attention. The Daily Diary Project sought to examine how sociodemographic factors, health status, personality characteristics, and genetic factors modify patterns of change in exposure to day-to-day life stressors as well as physical and emotional reactivity to those stressors.

The aim of this secondary data analysis is to utilize multilevel modeling via linear mixed modeling to examine how lifetime and daily experiences of discrimination, daily affect balance, baseline objective cognitive performance, and individual sociodemographic variables (age, race, ethnicity, and sex assigned at birth) affect everyday metamemory (i.e., number of subjective cognitive complaints). I hypothesize that (1) experiences of lifetime discrimination will be negatively associated with metamemory and (2) recent daily experiences of discrimination would, above and beyond, be negatively associated with metamemory; (3) daily affect balance would be positively associated with metamemory; and (4) based on previous research, I also hypothesize that objective cognitive performance would not be associated with impaired metamemory.

METHOD

Participants

This secondary data analysis uses data from a subset of participants recruited to participate in the Midlife Development in the United States (MIDUS) Refresher Study (Ryff et al., 2014, 2017), the MIDUS Refresher Study Cognitive Project, and the MIDUS Refresher Study Daily Diary Project, which was actively collecting data between 2012 and 2014. The MIDUS Refresher Daily Diary Project sought to capture how sociodemographic factors, health status, personality characteristics, and genetic endowment modified patterns of change in exposure to day-to-day life stressors, as well as physical and emotional reactivity to these stressors. Participation entailed completing an 8-day telephone diary study of self-reported daily stressors and well-being. Study data collected in the MIDUS Refresher Study and MIDUS Refresher Daily Diary project is publicly accessible through the National Archive of Computerized Data on Aging. A total of 782 individuals ages 26-75 (mean age = 47.91 years, SD = 12.67 years) that participated as a part of the MIDUS Refresher Study and the MIDUS Refresher Study Daily Diary Project were selected for these analyses.

Measures

Information Collected at Baseline

Demographics

Sex assigned at birth was coded dichotomously (0 = male; 1 = female). Age was captured as a continuous quantitative variable. Race was categorically recorded and coded as follows: 0 = white; 1 = black or African American; 2 = Native American or Alaskan Native; 3 = Asian American; 4 = Native Hawaiian or Pacific Islander; 5 = other. Ethnicity was coded dichotomously (0 = non-Hispanic; 1 = Hispanic).

Discrimination Exposure

Lifetime discrimination was assessed at baseline in the MIDUS Refresher Study via the 11-item subscale from the Perceived Discrimination Scale (Williams et al., 1997), in which participants subjectively report the number of lifetime discrimination experiences on the basis of race, ethnicity, gender, age, religion, physical appearance, sexual orientation, or other characteristics. The 11 categories include being discouraged from higher education, denied scholarship, not hired for a job, not given promotion, fired, prevented from renting or buying a home in the desired neighborhood, prevented from remaining in the neighborhood due to difficult neighbors, hassled by police, denied a bank loan, denied access to quality healthcare, and denied quality services. Scores were calculated from the number of categories endorsed. For analysis purposes, experience of lifetime discrimination was coded as follows: “0” = no endorsement of lifetime discrimination experiences and “1” = endorsement of 1 or more category of lifetime discrimination experiences.

Baseline Objective Cognitive Performance

Cognitive functioning at baseline was assessed using the Brief Test of Adult Cognition by Telephone (BTACT) (Tun & Lachman, 2006). The BTACT includes 7 subtests that provide an index of cognitive function in domains of key importance in cognitive aging, including episodic verbal memory, working memory, verbal fluency, processing speed, executive

functioning, fluid intelligence, and attention. These subtests are computed into three main composite scores: the BTACT composite, the Forgetting composite, and the Executive Functioning composite. The composite scores have been standardized as z-scores based on normative data for the sample population. For the purposes of these analyses, the BTACT and Forgetting composites were utilized.

Information Collected from the Daily Diary Project

Discrimination Exposure

Everyday discrimination was assessed in the MIDUS Refresher Daily Diary Project using a 9-item subscale of Williams and colleagues Perceived Discrimination Scale (1997), in which participants self-reported day-to-day experiences of discrimination as well as a perceived reason for their experienced discrimination. Participants were asked if they were treated differently, including receiving poorer service, being treated with less courtesy or less respect; were thought to be less smart, dishonest, or lacking; or were insulted or harassed. Individuals that experienced perceived discrimination were asked to indicate the “main reason” for their treatment, which included their age, gender, race, ethnicity/nationality, religion, height, weight, physical disability, sexual orientation, other appearance, and other reasons for discrimination. Scores are reverse-coded. The coefficient alpha for daily discrimination was good ($\alpha = .92$).

Subjective Cognitive Complaints

Cognitive complaints were assessed with daily cognitive failure questions in the MIDUS Refresher Study Daily Dairy Project, a 13-item measure in which participants subjectively report the number of cognitive failures (or instances of forgetting) perceived in the past 24 hours, including forgetting to do an errand or chore; forgetting to take a medication; forgetting to finish something that was started; forgetting an appointment; forgetting why one entered a room;

forgetting someone's name; forgetting where one put something; forgetting a word that one wanted to use; and forgetting important information.

Affect Balance

Affect was assessed with daily mood questions in the MIDUS Refresher Study Daily Diary Project, a 27-item measure in which participants subjectively endorsed positive (13-items) and negative (14-items) affective states experienced daily during their study participation (Almeida & Kessler, 1998; Mroczek & Kolarz, 1998; Watson, Clark, & Tellegen, 1988). Participants were asked "how much of the time today did you feel..." on a scale of 1 ("none of the time") to 5 ("all of the time"): restless/fidgety, nervous, worthless, sadness, everything was an effort, hopeless, lonely, afraid, jittery, irritable, ashamed, upset, angry, frustrated, in good spirits, cheerful, extremely happy, calm/peaceful, satisfied, full of life, close to others, like you belonged, enthusiastic, attentive, proud, active, and confident. The coefficient alpha for both measures of positive and negative affect were considered good ($\alpha = .96$ and $\alpha = .89$, respectively).

Data Preparation

Prior to data analysis, several variables were modified to facilitate the use of linear mixed models. Standardized scores for baseline objective cognitive performance provide information regarding an individual participant's cognitive abilities relative to individuals of their respective age group. Age as a predictor was grand mean centered because it is a Level 2 predictor (mean age = 47.91 years, SD = 12.67 years). The average number of cognitive complaints reported by participants were group mean centered based on their age group affiliation and z-scored to create meaningful zeroes to describe possible metamemory knowledge accuracy impairment (i.e., normal amount of forgetting versus unusual amount of forgetting). Affect balance was calculated

as a valence between endorsed negative and positive affect states, where negative values indicated overall negative affect and positive values indicated overall positive affect.

Data Analysis Plan

Due to the nested nature of the daily diary study, multilevel modeling via linear mixed models in SPSS was used to test the aims of these secondary data analyses. The multilevel analyses were sequentially specified, by incorporating additional predictors into each successive model, to produce nested models that could be statistically compared. Models were fitted using maximum-likelihood (ML) estimation. Three indices were interpreted to assess fit of these nested models. The -2 log likelihood (-2LL) indicated the extent to which the model coincides with the underlying data, where a lower -2LL signifies a better fitting model. Change in chi-square statistic, computed from the difference -2LL between two nested models, determined whether subsequent models were better than the null model. Additionally, Akaike's information criterion (AIC) and the Schwarz's Bayesian criterion (BIC) were assessed to judge model fit, where lower values indicated better fit. Unstructured covariance structure was used such that constraints were not imposed, allowing each variance and covariance to be freely estimated and resulting in the best model fit. The two-tailed significance was set at $\alpha = .05$. For models with significant effects, post hoc pairwise comparisons of estimated marginal means of the outcome of number of cognitive complaints was conducted and adjusted for multiple comparisons using the Šidák correction.

Prior to proceeding with using linear mixed models, a null model was generated to determine whether linear mixed modeling would be suitable based on interclass correlation, the amount of variance attributed to nesting. The current analyses called for a two level model, where at the lowest level (Level 1) contains the outcome variable of number of cognitive

complaints, and the predictors of perceived daily discrimination and daily affect balance reported over the course of the Daily Diary Project that is nested within each individual participant; and the highest level (Level 2) represents each individual participant and their individual demographics (including age, sex assigned at birth, race, ethnicity, baseline objective cognitive performance, and lifetime discrimination experience). The models constructed examined the following fixed effects on the outcome of number of reported subjective cognitive complaints: age, sex assigned at birth (male and female), race, ethnicity, objective cognitive performance at baseline, experience of lifetime discrimination as reported at baseline, experiences of daily discrimination and daily affect balance during the daily diary study.

Models 1 and 2 involved random intercepts with fixed-effect Level 1 and Level 2 predictors. Model 1 builds upon the null model by adding in Level 1 predictors of daily experience of discrimination and daily affect balance on number of reported subjective cognitive complaints during the 8-days of study participation in the Daily Diary Project. Model 2 incorporates Level 2 predictors at the individual participant level that was collected at baseline, including age, sex assigned at birth, race, ethnicity, cognitive performance, and lifetime discrimination experience. Model 2 also examined within and across level interactions between Level 1 and Level 2 variables. Thus, Models 1 and 2 took into account nesting by permitting intercepts to vary, while estimating fixed effects. Fit statistics comparing Models 1 and 2 with the null model determined whether adding each subsequent group of predictors improved model fit.

RESULTS

Sample Characteristics

Demographics

There were 782 individuals from the MIDUS Refresher Study that were enrolled in the MIDUS Refresher Daily Diary Project. Participants ranged from ages 26-75 (mean age = 47.91 years (SD = 12.67 years)), split for analytic purposes into three age groups to capture subjective experience from a life course perspective—younger (ages 26-39), middle-aged (ages 40-59), and older (ages 60-75)—with a majority of individuals in their midlife (n = 459, 58.7% of the sample). Most participants were female (55.6%) and non-Hispanic White (76.4%). In terms of retention rates, 80.2% of the respondents completed all eight interview days and 93.2% completed at least six interview days, contributing to an overall retention rate of 93.5%. Please see Table 1 for more information on sample demographics.

Table 1.*Descriptive Statistics of the Sample (N= 782)*

Age (47.91 years (SD = 12.67 years))	n
26-39	217 (27.7%)
40-59	459 (58.7%)
60-75	106 (13.6%)
Sex Assigned at Birth	n
Male	347 (44.4%)
Female	435 (55.6%)
Race	n
White	659 (84.3%)
Black	50 (6.4%)
Asian	7 (0.9%)
Native American/Alaskan Native	11 (1.4%)
Other	51 (6.5%)
Ethnicity	n
Hispanic/Latino	32 (4.0%)

Cognitive Abilities

Of the 782 individuals from the MIDUS Refresher Daily Diary Project, 761 individuals had baseline cognitive data collected prior to participating in the Daily Diary Project (mean = 9 months, SD = 4.28 months; range 3 to 22 months). Overall cognitive abilities among the individual participants varied from -2.62 to 2.96 points (z-scored values), with 96% falling within normal cognitive functioning. In regard to memory functioning, individual participants varied between -2.37 to 3.90 points (z-scored values), with 95.8% of individuals falling within normal range of memory functioning. Bivariate correlation analyses were conducted to determine whether differences in number of cognitive complaints reported corresponded with cognitive decline, which found that the average number of cognitive complaints was not significantly correlated with either overall cognitive functioning ($r = -.031$) or memory functioning ($r = -.024$). This indicates that greater number of cognitive complaints was not significantly related to objective cognitive performance.

Discrimination Experiences

Of the 782 individuals that participated in both the MIDUS Refresher and the daily diary study, 446 (57.03%) endorsed lifetime experiences of discrimination at baseline and 236 individuals (30.2%) reported experiencing at least one incident of discrimination while participating in the daily diary study. In total, 404 incidences of experienced discrimination across the eight daily diary days were analyzed in the current study. Information pertaining to the perceived type of discrimination experienced can be found in Table 2.

Table 2.

Summary Table of Reported Lifetime and Daily Discrimination Experiences

Reported Lifetime Experience of Discrimination at Baseline	
Yes	n = 446 (57.03%)
No	n = 336 (42.97%)
Individuals With At Least 1 Incident of Daily Discrimination Experienced During Daily Diary Project Participation	
Yes	n = 236 (30.2%)
No	n = 546 (69.8%)
Perceived Reason for Daily Discrimination Experience (per incident of discrimination)	
	N = 404 incidences
Age	70
Race/Ethnicity	58
Sex/Gender	51
Physical Disability	47
Other Appearance	41
Height/Weight	40
Religion	12
Sexual Orientation	7
Other	223
Don't know	39
Refused to say	7
Note: Though not explicitly stated, an incident of discrimination may have more than one basis/reason for discrimination.	

Subjective Cognitive Complaints

Self-reported cognitive complaints were recorded across the eight days during participation in the Daily Diary Project. The three most common cognitive complaints reported

by participants were forgetting where you put something (n = 937 endorsements), forgetting a word (n = 711 endorsements), and forgetting someone's name (n = 633 endorsements). On average, male participants reported more cognitive complaints compared with female participants. More information pertaining to the type of, number of, and average number of cognitive complaints across age groups and sex assigned at birth can be found in Table 3.

Table 3.

Summary of Subjective Cognitive Complaints Reported in Daily Diary Project

Number of Reported Cognitive Complaints	n
Forget where you put something?	937
Forget a word?	711
Forget someone's name?	633
Forget why you enter a room?	569
Forget errand or chore?	446
Forget to finish something you started?	425
Forget medication?	308
Forget important information?	214
Forget an appointment?	142
Average number of cognitive complaints per age group	
26-39	
Male	.973
Female	.531
40-59	
Male	.923
Female	.784
60-75	
Male	.695
Female	.115

Linear Mixed Models Analyses

Null Model

The null model represents how much of between (Level 2) and within person (Level 1) characteristics account for differences in the number of subjective cognitive complaints reported without any specific predictors. Within-person (Level 1) variance was calculated to be .740 and between-person (Level 2) variance was calculated to be .674. The interclass correlation

coefficient (ICC) calculated from these two variances was equal to .477 and found to be significant, signifying that over 47% of the variance in the number of reported subjective cognitive complaints can be explained by variations between individual participants in the Daily Diary Project. An ICC > .10 is enough justification for using multilevel modeling to examine between and within-person factors contributing to differences in subjective cognitive complaints reported (Hox, Moerbeek, & van de Schoot, 2017). The null model had the following relative model fit indices: -2LL = 16183.17, AIC = 16191.17 and BIC = 16217.81. See Table 4 for model fit comparisons.

Model 1 – Daily discrimination experiences and daily affect balance on number of subjective cognitive complaints (Within-Person Effect)

Model 1 examined the within person relationship between daily discrimination experiences, daily affect balance, and the number of cognitive complaints reported. There were significant fixed effects of daily discrimination experience ($\beta = -.462$, SE = .084, $p < .001$) and daily affect balance ($\beta = -.055$, SE = .008, $p < .001$) on the average number of cognitive complaints reported daily. Individuals that reported experiencing discrimination on a given day, on average, also reported .462 more complaints (95% CI [.298,.627], $p < .001$) compared with individuals that did not experience discrimination while participating in the Daily Diary Project. Positive affect was associated with .054 fewer complaints (95% CI [.038,.072], $p < .001$) compared to individuals that reported experiencing negative affect on a given day. See Table 5 for a summary of within-person fixed effects observed in Model 1. Model fit indices were enhanced when compared with the null model: -2LL = 16046.12, AIC = 16060.12, and BIC = 16106.73. However, between person difference still accounted for 56.3% of the variance, which

provides justification to examine the effect of Level 2 (individual level) predictors on subjective cognitive complaints.

Model 2 – Individual characteristics on number of reported cognitive complaints (Between-Person Effect)

Model 2 built upon Model 1 by examining how differences in individual characteristics, including age, sex assigned at birth, race, ethnicity, baseline cognitive performance, and lifetime experiences of discrimination, were associated with between-individual differences in the number of subjective cognitive complaints reported. There were significant main effects of race ($\beta = -.661$, $SE = .221$, $p = .003$), and ethnicity ($\beta = .682$, $SE = .327$, $p = .037$). The main effect of race indicated that white individuals reported, on average, .661 (95% CI [.229,1.09], $p = .003$) fewer complaints than non-white individuals. Furthermore, the main effect of ethnicity indicated that non-Hispanic individuals, on average, reported .682 (95% CI [.040,1.32], $p = .037$) more complaints compared with individuals that identified as Hispanic. The main effect of daily affect balance ($\beta = -.051$, $SE = .009$, $p < .001$) on the average number of cognitive complaints on a given day remained significant, in which individuals that reported experiencing more positive affect during the Daily Diary Project also reported fewer cognitive complaints. There were no significant main effects for age ($\beta = -.031$, $SE = .021$, $p = .138$), baseline cognitive performance ($\beta = -.024$, $SE = .041$, $p = .556$), endorsement of lifetime experiences of discrimination (reported at baseline) ($\beta = -.165$, $SE = .394$, $p = .676$), sex assigned at birth ($\beta = -.365$, $SE = .308$, $p = .237$), and daily discrimination experiences ($\beta = -.162$, $SE = .270$, $p = .547$). Model fit indices were improved compared with Model 1: $-2LL = 14939.63$, $AIC = 14999.63$, and $BIC = 15197.25$. See Table 5 for summary of between-person fixed effects observed in Model 2.

Model 2 also examined whether there were within and across level interactions between Level 1 and Level 2 variables. There was a significant interaction effect between daily experience of discrimination and endorsement of lifetime discrimination experiences ($\beta = -1.34$, $SE = .458$, $p = .003$), such that individuals that denied experiencing discrimination—whether lifetime or during their participation in the Daily Diary Project—on average, reported 1.34 (95% CI [.444,2.24], $p = .003$) fewer complaints compared with individuals that endorsed experiencing discrimination in their lifetime and while participating in the Daily Diary Project. Additionally, pairwise comparisons demonstrated a positive trend among individuals that endorsed experiencing lifetime discrimination and reported experiencing an incident of discrimination on a given day while participating in the Daily Diary Project, indicated by an increase in reported subjective cognitive complaints. There was a significant interaction effect between daily discrimination and race ($\beta = .537$, $SE = .200$, $p = .007$), such that after experiencing an incident of discrimination non-white individuals report, on average, .537 (95% CI [.145,.930], $p = .007$) more complaints compared with white individuals that did not report experience of discrimination. Furthermore, when both white and non-white participants reported experiencing an incident of discrimination on a given day in the Daily Diary Project, non-white individuals, on average, reported .422 (95% CI [.400,.443]) more complaints. There was a significant interaction effect between daily discrimination and ethnicity ($\beta = -.595$, $SE = .286$, $p = .037$), such that after experiencing an incident of discrimination on a given day, non-Hispanic individuals reported, on average, .595 (95% CI [.037,1.15], $p = .037$) more complaints compared with individuals of Hispanic descent. There was a significant interaction effect between daily discrimination and daily affect balance ($\beta = .019$, $SE = .192$, $p = .046$), such that individuals that reported very negative affect and experienced discrimination on a given day reported, on average, 2.04 (95%

CI [.014, 4.08]) more cognitive complaints. Lastly, there was an interaction effect between daily affect balance and age ($\beta = .001$, $SE = .0004$, $p = .004$), such that as age increased, more positive affect was reported. See Table 5 for summary of interaction effects observed in Model 2.

Each subsequent model was constructed to analyze the effect of predictors at the level of time (i.e., day) (Level 1) and at the level of individual characteristics (Level 2). Model fit improved with each model compared to the null model, indicating that each successive model was better at capturing the variance observed in the data compared with the null model without any predictors. A comparison of the model fit indices of Model 1 and Model 2 indicated that Model 2 was even better at capturing variance in the outcome variable of subjective cognitive complaints compared with Model 1. In other words, the inclusion of individual level characteristics (such as age, race, ethnicity, baseline cognitive performance, and lifetime experiences of discrimination) in addition to repeated daily predictors of daily discrimination experiences and daily affective state better explained within and between-individual differences in the average number of cognitive complaints reported in the Daily Diary Project.

Table 4.
Comparison of Model Fit Indices

<i>Model</i>	Δdf	-2LL	AIC	BIC	χ^2 Difference (based on -2LL)	p-value
<i>Null</i>	-	16183.17	16191.17	16217.81	-	-
<i>1</i>	10	16046.12	16060.12	16106.73	137.05	< .001
<i>2</i>	17	14931.29	14993.29	1519.50	1114.83	< .001

Table 5.
Summary of Fixed Effects

	MODEL 1			MODEL 2		
	β	p-value	95% CI	β	p-value	95% CI
LEVEL 1 PREDICTORS						
DAILY DISCRIMINATION EXPERIENCES	-.462	< .001	-.298, -.627	-.162	.547	-.691, .366
DAILY AFFECT BALANCE	-.055	< .001	-.072, -.038	-.052	< .001	-.069, -.033
LEVEL 2 PREDICTORS						
AGE				-.031	.138	-.072, .010
RACE				-.662	.003	-1.09, -.230
ETHNICITY				.682	.037	.040, 1.32
SEX				-.365	.237	-.970, .240
BASELINE OBJECTIVE COGNITIVE PERFORMANCE				-.024	.556	-.105, .057
ENDORSEMENT OF LIFETIME DISCRIMINATION				-.165	.676	-.939, .609
WITHIN-LEVEL INTERACTIONS						
DAILY DISCRIMINATION EXPERIENCES * DAILY AFFECT BALANCE				.019	.046	.0003, .038
CROSS-LEVEL INTERACTIONS						
DAILY DISCRIMINATION EXPERIENCES * RACE				.537	.007	.145, .930
DAILY DISCRIMINATION EXPERIENCES * ETHNICITY				-.595	.037	-1.15, -.037
DAILY DISCRIMINATION EXPERIENCES * ENDORSEMENT OF LIFETIME DISCRIMINATION				-1.34	.003	-2.24, -.444
DAILY AFFECT BALANCE * AGE				.001	.004	.0003, .002

DISCUSSION

Main Effects

Within-Person Effects

Findings from Model 1, which modeled within-person effects, extend prior research by demonstrating how daily discrimination experiences may influence metamemory as defined by the number of daily subjective cognitive complaints. Using multilevel analyses of daily diary data, daily experiences of discrimination were found to be positively associated with differences in the number of subjective cognitive complaints reported on a given day for a given person, without taking into account unique between-individual differences. In other words, on a given day, an average individual experiencing an incident of daily discrimination is more likely to report more subjective cognitive complaints compared with someone that did not experience an incident of daily discrimination. This main effect of daily discrimination experience on daily metamemory is in line with prior research on the impact of stereotype threats as a psychosocial stressor on stress processes that negatively impact self-efficacy and identity (Berjot and Gilet, 2011). Impaired self-efficacy and stereotyped threats to self-identity distorts one's knowledge of their own abilities. Therefore, one can delineate that an experience of discrimination, which undermines a person's identity and value, can impair a person's ability to accurately appraise their abilities—in this case, their memory. In other words, daily experiences of discrimination were associated with impaired metamemory.

Beyond daily experiences of discrimination, daily affect balance was significantly associated with subjective cognitive complaints, where more positive affect was associated with fewer reports of cognitive complaints. This main effect of daily affect balance replicates previous research on negative affect, depressed mood, and mood disorders in relation to subjective cognitive impairment and decline (Blazer et al., 1997; Brown et al., 2022; Lee et al., 2021). Furthermore, a main effect of daily affect balance demonstrates how the number of cognitive complaints reported can fluctuate depending on whether an individual experiences more positive or more negative affect, where very negative affect was associated with much greater reports of cognitive complaints compared to individuals with more balanced or positive affect.

Between-Person Effects

The main effect of race on the number of subjective cognitive complaints is in line with prior research on racial disparities in subjective cognitive impairment (Parisi et al., 2021). Furthermore, the main effect of race where non-White individuals were reporting greater subjective cognitive complaints adds to findings by Sangeeta Gupta (2021), which identified younger age, less education, lower income, and less access to healthcare as contributors to greater disparities in subjective cognitive decline among Black and Hispanic compared with White individuals in the United States. The main effect of ethnicity on the number of cognitive complaints was contrary to research findings that Hispanic individuals are more likely to report subjective cognitive complaints (Garcia et al., 2021; Huang et al., 2021). However, this finding reflects the Hispanic Paradox, also referred as the Immigrant Health Paradox, which reflects a psychological phenomenon in which immigrants and descendants of immigrants report lower physical and mental health concerns in spite of adverse and stressful experiences in the United States (Markides & Rote, 2015). Furthermore, this discrepant finding may be indicative of the

heterogeneity among individuals of Hispanic descent and their experiences with discrimination and lifetime stressors (Garcia et al., 2021). In other words, unique characteristics and experiences of individual sub-groups of Hispanic heritage (e.g., being of Puerto Rican versus Cuban descent) may differ in how subjective cognitive complaints were perceived and reported in this sample of Hispanic individuals compared with non-Hispanic white peers.

The lack of correlation between objective cognitive performance at baseline and subjective cognitive complaints reflects the larger body of literature highlighting mixed findings on their association (Burmester, Leathem, & Merrick, 2016). A meta-analysis conducted by Burmester and colleagues (2016) noted a small but significant correlation between more severe subjective memory complaints and poorer objective cognitive performance, which due to the less severe nature of subjective cognitive complaints reported in this current study was not replicated. The inclusion of baseline objective cognitive performance in Model 2 confirmed this lack of correlation, indicating that the number of reported cognitive complaints were not significantly associated by objective performance at baseline. However, the inclusion of baseline cognitive performance significantly improved model fit, highlighting that the inclusion of objective cognitive performance better explained the relationship of between-person differences and subjective cognitive complaints.

Interaction Effects

Furthermore, when taking individual characteristics of age, race, and ethnicity, as well as the endorsement of lifetime experiences of discrimination into account, significant interactions between daily affect balance and daily discrimination experiences with these characteristics provide a contextual understanding of how daily experiences impact everyday metamemory. The interaction effect observed between age and affect balance relates to research linking emotion

regulation and aging, where older adults often exhibit more affect balance and greater emotion regulation skills (Issacowitz, Livingstone, & Castro, 2017). Furthermore, older adults are more likely to focus on positive affect, as described by the socioemotional selectivity theory, that may contribute to fewer subjective cognitive complaints reported in older versus younger adults (Carstensen, Fung, & Charles, 2003). Thinking from the lens of the revised model of stress and coping (Folkman & Lazarus, 1985; Park & Folkman, 1997), as people age, they gain more resources to cope with and make meaning of psychological stress that emerges from threatening stimuli, while also gaining more perspective when appraising whether a stimulus is threatening or not. Therefore, developmentally, it may be that individuals become better at coping with subjective cognitive concerns, which the results of this micro-longitudinal study suggest.

The interaction effect observed between daily affect balance and daily discrimination provided additional context into how these two predictors related to metamemory impairment. When an individual reported very negative affect and experiencing an incident of discrimination, they were more likely to report greater cognitive complaints. However, when an individual reported very negative affect absent of experiencing an incident of discrimination, their report of cognitive complaints was only marginally greater, suggesting that although affect and discrimination experiences have shared variance, daily discrimination experiences exacerbated the influence of negative affect on subjective cognitive complaints.

The interaction found between daily discrimination experiences and an individual's race, where non-white individuals who reported daily experiences of discrimination noted more subjective cognitive complaints compared with white peers who also reported experiencing discrimination, highlight racial disparities related to impaired metamemory functioning that is consistent with recent research (Hill-Jarret & Jones, 2021; John et al., 2020). The heightened

response of non-white individuals to incidents of discrimination is consistent with the literature on how experiences of racism are associated with poorer memory and greater cognitive decline (Barnes et al., 2012; Seblova et al., 2022). Similarly, the interaction effect observed between daily discrimination experiences and ethnicity parallel research findings associating discrimination among individuals of Hispanic descent with greater psychological distress and poorer cognitive outcomes (Garcia et al., 2021; Torres, Driscoll, & Voell, 2013) Unlike the main effect of ethnicity, which held the effect of discrimination constant, this interaction accounted for daily discrimination experiences and highlighted how Hispanic individuals who experienced, processed, and reported a stressful experience of discrimination reported more subjective cognitive complaints. Exposure to adverse and stressful experiences and the subsequent emotional and physiological reactivity promotes dysregulation and possibly impairs metamemory.

Lastly, the interaction effect of daily discrimination experiences and lifetime discrimination experiences describe overall how the experience of discrimination contributes to disparities in subjective cognitive complaints. While individuals that denied any discrimination experiences on average reported substantially fewer cognitive complaints, individuals that endorsed lifetime experiences of discrimination displayed a profile indicating greater average number of subjective cognitive complaints. Furthermore, individuals that experienced an incident of daily discrimination during the Daily Diary study reported even more cognitive complaints compared to those that did not, suggesting that a predisposition to discrimination increases an individual's response to discrimination, resulting in greater metacognitive impairment. This finding is consistent with previous research on the impact of perceived lifetime discrimination as a psychosocial stressor that contributes to greater cognitive impairment (Keating et al, 2022;

Leger et al, 2022; Zahodne et al., 2022). Furthermore, this finding is consistent with and adds to recent research on the negative impact of lifetime discrimination as a psychosocial stressor on cognition and metamemory (Reyes et al, 2015), where discrimination not only negatively influences an individual's objective cognitive performance (Barnes et al., 2012) but also their beliefs, confidence, and judgments about their cognitive performance that could lead to stereotype embodiment (Levy, 2009) and contribute to actual memory deficits later in life.

Limitations of Current Study

While there were several strengths with using a micro-longitudinal dataset with the MIDUS daily diary study, there were also a number of limitations. First, although MIDUS sought to recruit a representative sample, individuals that chose to participate in the Daily Diary Project from the main MIDUS Refresher Wave were predominately non-Hispanic White. Self-reported incidents of discrimination were likely skewed towards the experience of the majority group, making it difficult to assess the various forms of discrimination that an individual might experience in everyday life. This skewed sample may contribute to the types of discrimination reported (e.g., more reports of age and gender discrimination compared with incidents of race/ethnicity and religious discriminations). Second, there was an overwhelming number of responses that indicated "other" as a reason for discrimination (n = 223), suggesting a limitation in how questions regarding discrimination experiences were presented. A few possible hypotheses emerged from this observation: (1) participants were unable to select one "main" reason for discrimination and used "other" to indicate multiple reasons for their discrimination experience; (2) participants felt that the reasons provided did not accurately capture their experience; (3) while participants were able to identify that their experience in itself was an incident of discrimination, they may not be able to accurately describe their own experience and

selected “other” as a means to cover all potential reasons for discrimination. Furthermore, the discrepancy between the number of participants that directly reported experiencing discrimination and those that endorsed “being treated” differently suggests the willingness to admit to being discriminated against varies across individuals and may be a byproduct of their socialization and cultural context. Third, having a majority of individuals list “other” as a reason for discrimination also precluded an expanded discussion on whether experiencing different forms/types of discrimination will have differential effects on metamemory outcomes. Fourth, the timing between objective cognitive assessment and participation in the Daily Diary Project (between three and 22 months) may inaccurately capture of an individual’s current cognitive abilities during their participation in the Daily Diary Project.

Implications and Directions for Future Research

Despite these limitations, the current findings have implications for both science and practice. With regard to science, reasons why Hispanic adults may demonstrate relatively better metamemory within the context of experienced discrimination need to be further studied. Clinically, the long-term influence of lifetime and daily discrimination on metamemory may “roll-up” to repeated threats to accurate memory judgments, feed internalized ageism, and potentiate actual cognitive decline. Future studies should examine the relations of experienced discrimination on metacognition as well as objective cognitive performance concomitantly. Future directions stemming from the findings of this study include uncovering and understanding the underlying mechanism of how psychosocial stressors like discrimination impact metacognition. One avenue for research includes leveraging the power of biological data, such as blood-based and saliva-based biomarkers of stress. The work of Reyes and colleagues (2015, 2020) have shown that psychosocial stress and biological stress reactivity were associated with

impairment of metacognitive knowledge accuracy. Salivary cortisol and, more recently, salivary alpha amylase have received increased attention as measures of biological stress response to psychosocial stressors, such as incidents of discrimination (Adam & Kumari, 2009).

Furthermore, investigating the duration of the stress response to an incident of discrimination through time-varying effect modeling, for example, could add to our understanding of the underlying mechanism. Examining changes in biological responses to stressful situations can provide a framework for a biological mechanism and pathway for intervention for subjective cognitive decline across the lifespan.

CONCLUSION

This study sought to understand the influence of lifetime and daily discrimination experiences across the lifespan on everyday metamemory accuracy. Findings from the MIDUS Refresher Daily Diary Project indicated that individuals who endorsed experiencing daily discrimination and negative affect balance exhibited poorer metamemory profiles. Furthermore, examining day-to-day reports of subjective cognitive complaints and their association with daily discrimination experiences, age, race, ethnicity, baseline cognitive performance, sex assigned at birth, and endorsement of lifetime experiences of discrimination suggest that daily discrimination experiences interact with race, ethnicity, and lifetime experiences of discrimination to have broad and variable effects on metamemory accuracy across the lifespan. Furthermore, the lack of relation between objective cognitive performance and subjective cognitive complaints replicates prior research, indicating independence between subjective cognitive complaints and concurrent cognitive performance. Modeling the significant effect of affect balance on subjective cognitive complaints adds to the substantial body of literature associating subjective cognitive complaints with symptoms of depression and other mood disorders. These findings, collectively, add to the literature on the impact of daily discrimination experiences and daily affect balance, extending findings to metacognitive health outcomes. Moreover, findings suggest a possible avenue targeting affect balance in individuals that have lifetime and daily experiences of discrimination to uncover a mechanism and pathway for intervention underlying the cognitive phenomenon of subjective cognitive decline.

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