

Sexual orientation and cognition in aging populations: Results from the Canadian Longitudinal Study on Aging

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ABSTRACT

The current study utilized the Canadian Longitudinal Study on Aging (CLSA) data to investigate the relationship between sexual orientation and cognitive health of the aging population. Cognitive flexibility and verbal fluency were examined as outcome variables in the study. A total of 45,993 respondents were included in the analyses. Each model had social support or social participation as a mediator. A series of mediation analysis, stratified by gender, revealed that aging gay men performed better in cognitive tasks related to cognitive flexibility when compared to their heterosexual counterparts. The results also indicated that social support is a protective factor for cognitive health in aging lesbian women. This study provides an opportunity to consider how clinical and social services can strategize to build inclusive environments for the aging sexual minority population.

1. Introduction

The current sexual minority literature includes a wealth of knowledge on sexual, mental, and physical health among youth and there is growing attention on aging populations (e.g. Fredriksen-Goldsen & Muraco, 2010; Kamen, Jabson, Mustian, & Boehmer, 2017; Lehavot & Simoni, 2011; Schwartz, Stratton, & Hart, 2016). Cognition, on the other hand, is not a key construct that has been extensively examined within sexual minority research. Although there are many research studies on aging and cognition, the current body of literature lacks consideration of diversity issues related to aging among sexual minorities (Correro & Nielson, 2020).

Informed by the minority stress model (Meyer, 2003), this study aims to address the gap in current research through examining how sexual minority status can affect cognitive outcomes among aging adults. Minority stress model outlines social support as a protective factor between sexual orientation and health outcomes (Meyer, 2003). Larger social network size and the amount of social support have positive relationships with mental and physical health among aging sexual minority adults (Fredriksen-Goldsen, Kim, Barkan, Muraco, & Hoy-Ellis, 2013). However, social isolation due to limited social support and participation

associated with heterosexism and ageism poses a potential challenge for aging sexual minority adults' cognitive health (Correro & Nielson, 2020; Fredriksen-Goldsen, Jen, Bryan, & Goldsen, 2016). Even though research studies on cognitive health for the general population indicate that greater social support is positively associated with cognitive function (Oremus et al., 2019; Pillemer & Holtzer, 2016), there is a limited understanding of the role that various social resources can play in aging and cognition among sexual minorities. Hence, this study will specifically explore the role of social support, as well as the effect of social participation, in the relationship between sexual orientation and cognitive performance among older adults. The current study will focus on two cognitive functions, cognitive flexibility through Mental Alteration Test and verbal fluency through the Animal Fluency Test, as these have been used to detect early cognitive declines related to dementia (Findlay, Bernier, Tuokko, Kirkland, & Gilmour, 2010; Read, 1987; Rofes et al., 2020; Salib & McCarthy, 2002; Teng, 1994; Teng, 1995). By doing so, the study aims to highlight the importance of inclusive practices within policy and clinical settings in order to create better environments for healthy aging for sexual minority adults. More specifically, the study hypothesizes that there will be a difference in cognitive performance between aging sexual minority adults and heterosexual adults

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based on [Correro and Nielson \(2020\)](#) theoretical insights. Furthermore, the study hypothesizes that social factors such as social support and social participation will have influence on the relationship between sexual minority status and cognition for aging adults ([Correro & Nielson, 2020](#); [Meyer, 2003](#)). Additionally, the study predicts that each gender would show different patterns of cognitive performance in relation to their sexual minority status because previous studies have indicated that gender stratification reflects health outcomes through different lived experiences ([Brennan et al., 2010](#); [Steele et al., 2009](#); [Yang et al., 2023](#)).

1.1. Cognition and aging population

Prolonged experiences of chronic stress can lead to allostatic load, a physiological response to stress ([McEwen & Gianaros, 2010](#)). This can elevate the risk of cognitive problems for older adults due to high level of glucocorticoids, which is linked to decreased neurogenesis and reduction of hippocampal size ([de Souza-Talarico, Marin, Sindi, & Lupien, 2011](#); [Zsoldos et al., 2018](#)). Higher levels of glucocorticoids have also been associated with the thickness of prefrontal region in the brain, suggesting the relationship between stress and executive function ([Kremen et al., 2010](#)). Therefore, there is a reason to hypothesize that the cumulative effects of stress throughout the life-course, given the long-standing history of pervasive criminalization and medicalization of homosexuality ([Correro & Nielson, 2020](#); [King & Richardson, 2016](#); [Smith, 2005](#)), could act as negative contributing factors for the cognitive outcomes of aging sexual minority adults.

Recent studies of cognitive disparities between aging sexual minority and heterosexual adults have reported conflicting results ([Brown & Patterson, 2020](#); [Hsieh, Liu, & Lai, 2021](#); [Perales-Puchalt et al., 2019](#); [Seelman, 2019](#); [Stinchcombe & Hammond, 2022](#)). While [Hsieh et al. \(2021\)](#) found higher risk of cognitive impairment in aging sexual minority adults compared to aging heterosexual adults using a single measure that assessed a variety of cognitive factors through the Montreal Cognitive Assessment (memory, attention, executive function, visuospatial, language, and temporal orientation), [Brown and Patterson \(2020\)](#) utilized the subjective cognitive decline measure from the Behavioral Risk Factor Surveillance System data and did not find a significant difference in cognitive decline between these two populations. Moreover, [Perales-Puchalt et al. \(2019\)](#) examined the risk of dementia, assessed by clinicians, and found that aging adults who are in same-sex relationships did not report any significant difference in cognitive impairment compared to aging adults who are in different-sex relationships. Additionally, a study by [Seelman \(2019\)](#) revealed that aging bisexual women showed higher rates of self-reported cognitive difficulties, but there was no difference in cognitive health between aging lesbian and heterosexual women. On the other hand, a recent study by [Stinchcombe and Hammond \(2022\)](#) reported that aging sexual minority adults had higher memory function, measured by Rey Auditory Verbal Learning Test, compared to their heterosexual counterparts. These mixed results point to a gap in literature that needs to be filled by more comprehensive studies that examine relevant potential mediators to explore aging and cognitive health in the sexual minority population, including attention to potential differences between subgroups within sexual minority communities. Hence, the current study contributes to such need through the investigation of executive functions with the baseline data from the Canadian Longitudinal Study on Aging (CLSA) survey since previous studies have focused on memory related cognitive functions when determining older adults' cognitive decline (e.g. [Brown & Patterson, 2020](#); [Flatt et al., 2021](#)). Cognitive flexibility is a major component of executive function that influences the capacity to regulate cognitive processes and behaviors ([Amunts, Camilleri, Eickhoff, Heim, & Weis, 2020](#)). Also, verbal fluency involves retrieval of information ([Tuokko, Griffith, Simard, & Taler, 2017](#)). Therefore, our study examines processing speed and information retrieval of aging adults. While investigating these key components, age, education level, income, and relationship status were considered as control variables in our study.

Examining key cognitive measures, with attention to important potential mediators, will enable further insights on aging among sexual minorities.

1.2. Theoretical framework

The Minority stress model posits that the higher prevalence of mental health problems, such as depression and anxiety, that can be observed in the sexual minorities relative to heterosexuals are a result of the unique form(s) of stress that they experience ([Meyer, 2003](#)). The model outlines distal minority stressors, proximal minority stressors, sexual minority identity, characteristics of minority identity, and social support as its main constructs. Distal stressors refer to external influences that elicit stress, which include physical assaults, verbal insults, workplace harassment, and service refusal, among others ([Ramirez & Galupo, 2019](#)). Proximal stressors refer to internal process that are related to self-stigmatization, which originates in negative social attitudes regarding minority identity ([Meyer, 2003](#)). These can include internalized phobia regarding their own sexual orientation and hiding their identities ([Ramirez & Galupo, 2019](#)). Additionally, social support within the minority stress model includes both community and individual levels of support ([Meyer, 2003](#)).

As the importance of cognition is not discussed in the minority stress model and has not yet been investigated in detail, our research seeks to use some of the constructs that are outlined in the model (including sexual orientation and social support) to examine how they may impact cognitive well-being among aging sexual minorities. Exposure to various proximal and distal stressors throughout aging sexual minority adults' lives can lead to higher levels of stress hormones such as cortisol, which are associated with risk of cognitive decline ([Correro & Nielson, 2020](#)). In addition, social support has been identified as a significant factor that influences aging sexual minority adults' health outcomes ([Fredriksen-Goldsen et al., 2013](#); [Fredriksen-Goldsen & Muraco, 2010](#)). Our models have social support, which was suggested as an ameliorating factor in Meyer's framework (2003), as a mediator. Furthermore, social participation was included as another potential area of exploration since receiving social support and actively engaging in activities would have different impacts on cognition. Given the nature of the population-based survey that the current study is utilizing, items related to proximal and distal stressors that are unique to sexual minority status were not included. However, social factors were included in the survey. Hence, the current study is interested in how social support and social participation can help us understand the relationship between aging and cognition in the sexual minority population.

Since minority stress model has been used to investigate the relationship between sexual orientation and other aspects of well-being, including mental and physical health, the current study aims to build on this foundation by examining cognition as another health outcome of concern for sexual minorities.

1.3. Aging sexual minority populations and social factors

Social resources such as social support and networks have been indicated as key aspects of aging in sexual minority adults ([Kim, Fredriksen-Goldsen, Bryan, & Muraco, 2017](#); [Lyons, 2016](#); [Masini & Barrett, 2008](#)). A lack of social support, such as the absence of family members and partners who can support and advocate for sexual minority adults, is one of the main concerns that has been identified in the literature ([Wilson, Kortess-Miller, & Stinchcombe, 2018](#)). Financial difficulties, retirement, end-of-life care, and housing are other issues that are closely related to the lack of access to social and health services that can contribute to social and financial resources ([Cronin & King, 2010](#); [Wilson et al., 2018](#)). Given the previous findings related to social resources and health outcomes in the aging sexual minority population, it is critical to examine the importance of social support and social participation's role in relation to cognitive health in this population.

Moreover, detailed analysis regarding how different subgroups' cognition is influenced by social resources would solidify our understanding of sexual minority aging as a previous study has indicated that aging bisexual people have lower levels of social support compared to their gay and lesbian counterparts (Stinchcombe, Hammond, & Wilson, 2020).

Stigma can also reduce social interactions in the aging sexual minority population. For example, previous research has shown that aging sexual minority adults do not express their sexual identity in long-term care settings due to the fear of discrimination (McFarland & Sanders, 2003; Stein, Beckerman, & Sherman, 2010). Studies on aging sexual minority adults have also revealed that they are less likely to be married or have children (Shankle, Maxwell, Katzman, & Landers, 2003; Guasp, A., 2011). Living with a partner instead of living alone has been found to elicit better mental health outcomes for aging sexual minority adults (Grossman, D'Augelli, & Hershberger, 2000). These suggest that there is often a severe absence of social support for aging sexual minority individuals that can become an increasingly significant risk factor for an individual as they age. In addition, aging sexual minority adults often experience disconnect with their extended family due to their sexual orientation (Barrett, Whyte, Comfort, Lyons, & Cramer, 2015). Because social isolation is associated with physical stress responses that impact cognitive ability, social support and participation are important to explore.

1.4. Social support, participation, and cognition

In the general population, a Canadian population-based study has indicated that the level of social support had a positive relationship with cognitive functions of the aging adults (Oremus et al., 2019). In addition, a study that was conducted in the United Kingdom revealed that there is an association between social participation and cognition (Bowling, Pikhartova, & Dodgeon, 2016). Similarly, a European study also reported that there is a positive relationship between activity participation and cognitive performance related to memory (Litwin & Stoeckel, 2016). Therefore, it is important to observe whether similar pattern is present in the aging sexual minority population. Considering the potential risk related to low social resources, the current study investigates how social support and participation levels contribute to the relationship between sexual orientation and cognition.

2. Methods

2.1. Data source

The Canadian Longitudinal Study on Aging (CLSA) is the first Canadian population-based survey to collect sexual orientation data for people over the age of 60, and therefore is the optimal data source for the current study. Our study utilized the baseline data from CLSA, which were collected between 2011 and 2015 (CLSA, 2018; Raina et al., 2019) and included adults aged 44 to 89. A total of 51,338 people participated in the survey. Data were collected through telephone or in-person interview.

2.2. Sample

A total of 45,993 respondents were included in the analyses: 747 gay/lesbian, 228 bisexual, and 45,018 heterosexual adults. The sample had a mean age of 62.45 ($SE = 0.05$). A total of 5320 respondents were excluded from the analyses through listwise deletion based on missing items related to sexual orientation, mediators, and control variables. In addition, 42 respondents that reported having dementia and/or Alzheimer's disease were excluded from our analyses. In total, 5362 (10.44 %) respondents were removed due to one or more missing variables and/or self-reported cognitive problems. Detailed demographics are outlined in Table 1.

Table 1

Demographic information (baseline characteristics of respondents).

	Heterosexual (n = 45,018)	Gay/Lesbian (n = 747)	Bisexual (n = 228)
Age, $M(SE)$	62.52 (0.05)	58.84 (0.32)	60.02 (0.66)
Sex, n(%)			
Women	22,671 (50.36)	254 (34.00)	112 (49.12)
Men	22,347 (49.64)	493 (66.00)	116 (50.88)
Relationship Status, n(%)			
Single	3302 (7.33)	281 (37.62)	63 (27.63)
Married/Common-law	32,179 (71.48)	375 (50.20)	102 (44.73)
Widowed	4043 (8.98)	25 (3.35)	20 (8.77)
Divorced	4345 (9.65)	48 (6.43)	31 (13.60)
Separated	1158 (2.57)	18 (2.41)	12 (5.26)
Household Income, n(%)			
< \$20,000	2510 (5.578)	50 (6.69)	31 (13.60)
\$20,000	11,170 (24.81)	181 (24.23)	63 (27.63)
\$50,000	16,158 (35.89)	266 (35.61)	79 (34.65)
\$100,000	8372 (18.60)	142 (19.01)	37 (16.23)
\$150,000	6808 (15.12)	108 (14.46)	18 (7.89)
Education, n(%)			
Less than Secondary	3032 (6.74)	17 (2.28)	13 (5.70)
Secondary graduation, no postsecondary	4972 (11.04)	57 (7.63)	28 (12.28)
Some Postsecondary	3348 (7.44)	60 (8.03)	22 (9.65)
Postsecondary degree/diploma	33,666 (74.78)	613 (82.06)	165 (72.37)
Social Support, $M(SE)^*$	82.06 (0.08)	79.45 (0.72)	76.37 (1.30)
Social Participation, $M(SE)^{**}$	11.60 (0.02)	10.80 (0.17)	11.34 (0.32)

* Potential range: minimum 0 to maximum 100; Statistically significant mean differences were observed ($p < 0.01$) between heterosexual and gay/lesbian adults as well as between heterosexual and bisexual adults. There was no statistically significant mean difference between gay/lesbian and bisexual adults.

** Potential range: minimum 0 to maximum 32; Statistically significant mean difference was observed ($p < 0.01$) between heterosexual and gay/lesbian adults. No other mean differences were observed.

2.3. Measures

2.3.1. Sexual orientation. A self-reported sexual orientation item was included in the CLSA. Survey participants were able to choose from five options: heterosexual, homosexual, bisexual, don't know, and refused. Respondents that chose don't know or refused option were excluded from our analyses.

2.3.2. Control variables. Four control variables were included based on their impact on cognition, as outlined above: age, education, relationship status, and income. Age was reported in years. Education was broken into four categories: less than secondary school; graduated secondary school; some post-secondary education; post-secondary degree/diploma. Similarly, another study that utilized the CLSA data has used education on a scale (Demnitz et al., 2018). Relationship status was coded as single/not partnered (including widowed, divorced, and separated individuals) and married/living with a partner. This approach has been used by studies that utilized the CLSA data (e.g. Stinchcombe et al., 2020). Total household income was categorized into five groups from low (less than \$20,000) to high (\$150,000 or more).

2.3.3. Social support. Perceived social support was measured with a modified version of the Medical Outcomes Study (MOS) Social Support Survey (Sherbourne & Stewart, 1991). The MOS total scores out of 100 was derived by the CLSA and higher scores indicate better social support availability (CLSA, 2018). Questions regarding emotional, tangible, and affectionate social support as well as positive social interaction were included (e.g., "How often is each of the following kinds of support available to you if you need it?") with 5-point scale from "none of the time" to "all of the time" (Sherbourne & Stewart, 1991). The MOS was

used in previous studies drawing from the CLSA to report on the relationships between mental health and social relationships (Harasemiw, Newall, Shooshtari, Mackenzie, & Menec, 2018; Oremus et al., 2019). The MOS measures various aspects of social support including available social support in their everyday lives or during an emergency, someone that can provide support through affection, positive social interaction, and someone that can consult with (Sherbourne & Stewart, 1991). For our study, Cronbach's alpha for 19-items was 0.95.

2.3.4. Social participation. Overall social participation score was calculated based on eight social activities: education or cultural; club or organization; neighborhood; volunteer; outing; sports; religious; and other recreational activities. The range for possible score is from 0 to 32. Frequency of engagement was coded as: 0 (never), 1 (once a year), 2 (once a month), 3 (once a week), and 4 (once a day) (Harasemiw et al., 2018). Cronbach's alpha was 0.63, which is in the acceptable range of internal consistency.

2.3.5. Cognition. All measures that are sensitive to cognitive decline and were included in the CLSA were used in this analysis: (1) the Mental Alternation Test (Teng, 1994; Teng, 1995) measures cognitive flexibility by measuring the accurate chronological pairing of the numbers and the alphabet (i.e. 1-A, 2-B, 3-C, and so on) and (2) the Animal Fluency Test measured respondents' verbal fluency by asking them to name as many animals as they can in 60 s (Findlay et al., 2010; Read, 1987). Although other cognitive measures were available for the CLSA's baseline data, the current study focused on these two measures in order to conduct our analyses with a bigger sample size since the Mental Alternation Test and Animal Fluency Test were conducted for both telephone and in-person data collection cohorts.

2.4. Analysis plan

A series of mediation analyses were carried out using SPSS. Using the PROCESS package (Hayes, 2022), ordinary least squares regression analyses were conducted. Each mediation model included social support or social participation as mediators. Cognition variables (verbal fluency and cognitive flexibility) were designated as outcome variables separately in each analysis. Age, education, household income, and relationship status were added into each model as control variables (see Fig. 1).

Two sets of analyses were conducted. The first analysis tested for mediation effects of social support and social participation between heterosexual and sexual minority adults. The analysis for heterosexual and gay/lesbian adults was carried out separately from the analysis of heterosexual and bisexual adults. The second analysis tested for mediation effects of social support and social participation between gay/lesbian and bisexual adults. All analyses were stratified by gender and repeated for each cognitive variables: cognitive flexibility and verbal fluency. Bootstrapping method was used for each mediation analysis as "bootstrapping is used to generate an empirically derived representation of the sampling distribution of the indirect effect" (Hayes., 2022, p. 100). For each model, 5000 bootstrap samples were used as a previous study has indicated that over 500 bootstrap replications with a large sample size did not show a significant difference (Deng, Allison, Fang, Ash, & Ware, 2013). Due to the limited number of cognitive measures that were used in previous studies, sexual minority researchers' understanding of cognition and aging in the sexual minority population was mixed. Our results provide a more details regarding executive functions by outlining how the influence of sexual orientation can be varied in cognitive performance related to processing speed and information retrieval. Also, each analysis was stratified by gender based on a research team's previous approach that utilized the Canadian

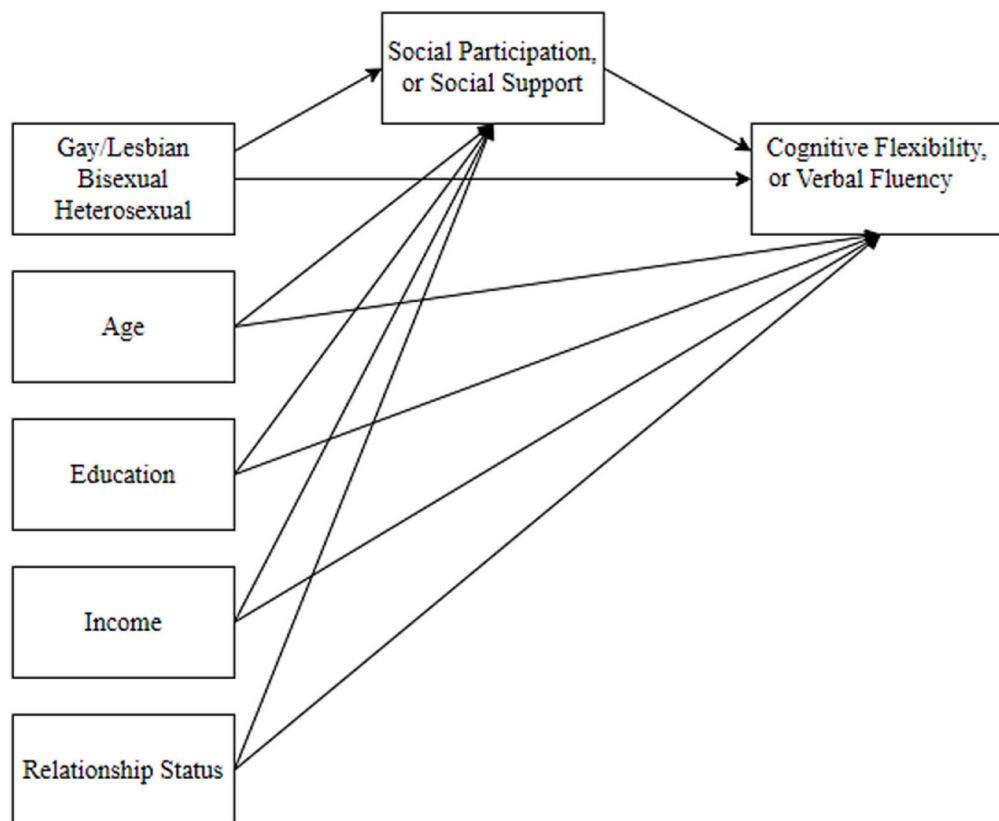


Fig. 1. Mediation model.

Note. Each analysis was stratified by gender.

Community Health Survey by conducting analyses separately (Brennan et al., 2010; Steele et al., 2009). Such stratification allows the current study to focus the scope on sexual orientation in order to highlight the need to consider sexual orientation and gender identity separately.

3. Results

Mediation analyses were conducted to explore the influence of social support and social participation in the relationship between sexual orientation and cognition in the aging population while controlling for age, education, household income, and relationship status. None of the covariates showed a strong correlation with ($r < 0.5$) each other, mediators, and cognition for both aging women and men based on the Pearson correlation coefficient (Mukaka, 2012). However, statistically significant relationships were observed between all covariates, mediators, and cognition measures for both aging women and men ($p < 0.05$). Some positive correlations were observed ($r > 0.3$) between cognitive flexibility and verbal fluency in both aging women and men. In addition, some negative correlations ($r < -0.3$) were observed between age and verbal fluency as well as between age and income for both aging women and men. Due to some missing cognitive scores, analysis regarding sexual minority men's cognitive flexibility included 20,777 heterosexual, 456 gay, 108 bisexual men and verbal fluency included 21,734 heterosexual, 483 gay, 114 bisexual men. Similarly, analysis regarding sexual minority women's cognitive flexibility included 21,098 heterosexual, 244 lesbian, 104 bisexual women and verbal fluency included 22,025 heterosexual, 246 lesbian, 105 bisexual women.

3.1. Sexual minority identity and cognition in aging men

For aging men involving social support as a mediator in the model, direct effects of gay identity (difference between heterosexual and gay adults) on cognition were statistically significant for cognitive flexibility ($\beta = 0.936$, 95 % CI [0.113, 1.759]), showing higher cognitive performance for aging gay adults (see Fig. 2). Verbal fluency was also higher for gay adults, but the difference was not statistically significant ($\beta = 0.152$, 95 % CI [-0.335, 0.638]). Indirect effects of gay identity on cognition through social support were not significant for both cognition measures, showing no indirect effect of homosexuality via social support when compared to their heterosexual counterparts (cognitive flexibility: $\beta = 0.042$, 95 % CI [-0.005, 0.092]; verbal fluency: $\beta = 0.032$, 95 % CI [-0.004, 0.068]). Total effects (the sum of direct and indirect effects) indicated that gay men performed significantly better in cognitive tasks in cognitive flexibility after accounting for indirect effects of homosexuality on cognition via social support ($\beta = 0.978$, 95 % CI [0.154, 1.801]), however, no significant result was found in verbal fluency ($\beta = 0.183$, 95 % CI [-0.304, 0.670]).

For aging men involving social participation as a mediator in the model, direct effects of gay identity on cognition were statistically significant for cognitive flexibility ($\beta = 1.013$, 95 % CI [0.190, 1.835]), showing higher cognitive performance for aging gay adults. There was no direct effect of gay identity on verbal fluency ($\beta = 0.206$, 95 % CI

[-0.281, 0.692]). The indirect effects of gay identity on cognition through social participation were negative, but not statistically significant for both cognition measures for aging gay adults compared to heterosexual men (cognitive flexibility: $\beta = -0.035$, 95 % CI [-0.081, 0.008]; verbal fluency: $\beta = -0.023$, 95 % CI [-0.050, 0.003]). Despite negative indirect effects of gay identity on cognition via social participation (see Fig. 3), total effects indicated that gay men still performed significantly better in cognitive tasks related to cognitive flexibility ($\beta = 0.978$, 95 % CI [0.154, 1.801]). No significant result on total effect was found in verbal fluency ($\beta = 0.183$, 95 % CI [-0.304, 0.670]). Thus, direct and total effects indicate better cognitive flexibility among gay men relative to their heterosexual counterparts.

There were no direct effects of bisexual identity on cognition among men when comparing aging bisexual and heterosexual men when social support (cognitive flexibility: $\beta = 1.018$, 95 % CI [-0.640, 2.676]; verbal fluency: $\beta = -0.622$, 95 % CI [-1.603, 0.359]) or social participation (cognitive flexibility: $\beta = 1.047$, 95 % CI [-0.611, 2.705]; verbal fluency: $\beta = -0.639$, 95 % CI [-1.621, 0.343]) was involved in the model. No significant indirect effects of bisexuality via social support were observed for cognitive performance for the difference between aging heterosexual and bisexual men in all measures. Negative indirect effects of bisexuality via social support for verbal fluency scores were reported for aging bisexual men compared to heterosexual men (verbal fluency: $\beta = -0.013$, 95 % CI [-0.086, 0.060]), but not for cognitive flexibility ($\beta = 0.025$, 95 % CI [-0.063, 0.116]). These effects were not statistically significant. Indirect effects of bisexuality via social participation on cognition were not found for aging bisexual men when compared to heterosexual counterparts (cognitive flexibility: $\beta = -0.004$, 95 % CI [-0.095, 0.087]; verbal fluency: $\beta = 0.004$, 95 % CI [-0.050, 0.059]). Additionally, none of the total effects were significant for the comparison between bisexual and heterosexual men for both models with social support (cognitive flexibility: $\beta = 1.043$, 95 % CI [-0.617, 2.703]; verbal fluency: $\beta = -0.635$, 95 % CI [-1.618, 0.349]) or social participation (cognitive flexibility: $\beta = 1.043$, 95 % CI [-0.617, 2.703]; verbal fluency: $\beta = -0.635$, 95 % CI [-1.618, 0.349]) as a mediator. Lastly, statistically significant direct, indirect (via social support or social participation), and total effects were not observed when comparing cognitive scores of aging gay and bisexual men.

3.2. Sexual minority identity and cognition in aging women

While there were no direct effects of sexual orientation in aging women when mean cognition scores were compared between lesbian and heterosexual women with social support as a mediator in the model (cognitive flexibility: $\beta = -0.398$, 95 % CI [-1.510, 0.714]; verbal fluency: $\beta = 0.232$, 95 % CI [-0.437, 0.902]), positive indirect effects were observed between lesbian identity and cognition in women when social support was considered as a mediator (See Fig. 2). Specifically, the indirect effects of lesbian identity on cognition through social support was significant for both cognition measures, showing higher cognition scores for aging lesbian adults compared to their heterosexual counterparts (cognitive flexibility: $\beta = 0.066$, 95 % CI [0.023, 0.115]; verbal

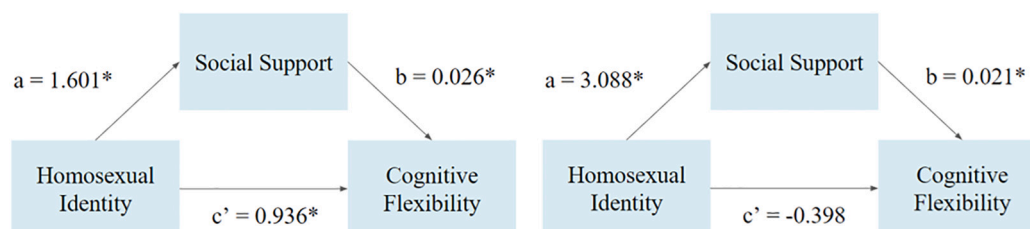


Fig. 2. Social Support on Cognitive Flexibility (Gay/Lesbian and Heterosexual Adults).

Note. * Indicates statistical significance ($p < 0.05$). Left: a direct effect showing a statistically significant result of gay identity on cognitive flexibility, showing higher cognitive performance for aging gay adults. Right: a positive indirect effect was observed between lesbian identity and cognitive flexibility when social support was considered in the model. No statistically significant direct effect.

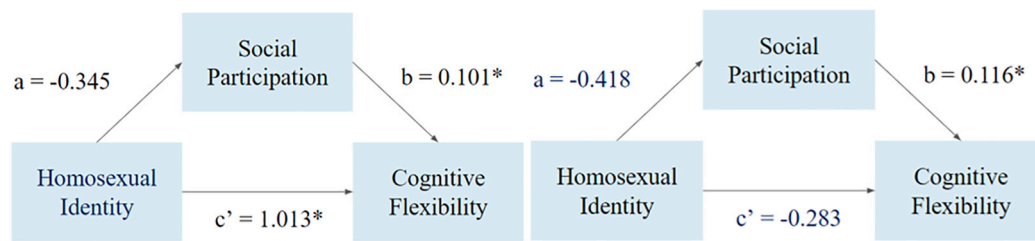


Fig. 3. Social Participation on Cognitive Flexibility (Gay/Lesbian and Heterosexual Adults).

Note. * Indicates statistical significance ($p < 0.05$). Left: a direct effect showing a statistically significant result of gay identity on cognitive flexibility, showing higher cognitive performance for aging gay adults despite the negative indirect effect of social participation. Right: no direct or indirect effects observed for lesbian identity on cognitive flexibility when considering social participation in the model.

fluency: $\beta = 0.041$, 95 % CI [0.015, 0.071]). None of the models with social support as a mediator showed significant total effects (cognitive flexibility: $\beta = -0.332$, 95 % CI [-1.445, 0.781]; verbal fluency: $\beta = 0.274$, 95 % CI [-0.397, 0.944]).

No direct effects of sexual orientation in aging women were observed when mean cognition scores were compared between lesbian and heterosexual women with social participation as a mediator in the model (cognitive flexibility: $\beta = -0.283$, 95 % CI [-1.392, 0.825]; verbal fluency: $\beta = 0.313$, 95 % CI [-0.353, 0.980]). No indirect effects of lesbian identity via social participation were observed (cognitive flexibility: $\beta = -0.048$, 95 % CI [-0.111, 0.008]; verbal fluency: $\beta = -0.039$, 95 % CI [-0.085, 0.004]). Total effects of mediation models including social participation were not statistically significant (cognitive flexibility: $\beta = -0.332$, 95 % CI [-1.445, 0.781]; verbal fluency: $\beta = 0.274$, 95 % CI [-0.397, 0.944]). Although direct and total effects did not indicate a statistically significant difference in cognition among lesbian women relative to their heterosexual counterparts, our analyses indicate that social support is a significant mediator between sexual orientation and cognition in aging women while social participation is not.

Examination of a potential direct effect of sexual orientation on cognition in aging women when considering social support as a mediator and comparing between bisexual and heterosexual women indicated there are no significant direct effects (cognitive flexibility: $\beta = 0.124$, 95 % CI [-1.602, 1.850]; verbal fluency: $\beta = 0.297$, 95 % CI [-0.715, 1.309]). No indirect effects of bisexual identity on cognition were observed via social support when we compared aging heterosexual and bisexual women (cognitive flexibility: $\beta = -0.013$, 95 % CI [-0.085, 0.054]; verbal fluency: $\beta = -0.014$, 95 % CI [-0.059, 0.029]). Total effects showed that relationship between bisexuality and cognitive function while considering social support in the model is not statistical significant (cognitive flexibility: $\beta = 0.111$, 95 % CI [-1.611, 1.832]; verbal fluency: $\beta = 0.345$, 95 % CI [-0.656, 1.346]).

Furthermore, direct effect of bisexuality was not observed when comparing between bisexual and heterosexual women while considering social participation in cognitive outcomes (cognitive flexibility: $\beta = 0.042$, 95 % CI [-1.665, 1.749]; verbal fluency: $\beta = 0.227$, 95 % CI [-0.788, 1.232]). No indirect effects of bisexuality were observed via social participation when comparing aging heterosexual and bisexual women (cognitive flexibility: $\beta = 0.069$, 95 % CI [-0.029, 0.175]; verbal fluency: $\beta = 0.057$, 95 % CI [-0.015, 0.132]). The total effect were not statistically significant when considering social participation as mediators in the model for the comparison between aging bisexual and heterosexual women (cognitive flexibility: $\beta = 0.111$, 95 % CI [-1.611, 1.832]; verbal fluency: $\beta = 0.284$, 95 % CI [-0.725, 1.293]).

Finally, the effects of sexual minority status on aging sexual minority women's cognition were investigated by considering social support and social participation as mediators in separate models while controlling for education, household income, relationship status, and age. There were no significant direct effects of sexual minority status on cognition for aging lesbian and bisexual women (cognitive flexibility: $\beta = 0.195$, 95 % CI [-1.852, 2.243]; verbal fluency: $\beta = 0.156$, 95 % CI [-1.088,

1.401]). Furthermore, no indirect effects were observed via social support when comparing aging lesbian and bisexual women (cognitive flexibility: $\beta = -0.059$, 95 % CI [-0.370, 0.189]; verbal fluency: $\beta = -0.056$, 95 % CI [-0.301, 0.133]). Total effects of these models were not significant (cognitive flexibility: $\beta = 0.137$, 95 % CI [-1.897, 2.170]; verbal fluency: $\beta = 0.101$, 95 % CI [-1.146, 1.347]).

For sexual minority women model including social participation as a mediator, there were no significant direct effects (cognitive flexibility: $\beta = -0.133$, 95 % CI [-2.170, 1.904]; verbal fluency: $\beta = -0.056$, 95 % CI [-1.310, 1.198]). Indirect effects of sexual orientation on cognition via social participation were not significant (cognitive flexibility: $\beta = 0.270$, 95 % CI [-0.013, 0.719]; verbal fluency: $\beta = 0.157$, 95 % CI [-0.013, 0.432]). No significant total effects were found for cognitive flexibility ($\beta = 0.137$, 95 % CI [-1.897, 2.170]) and verbal fluency ($\beta = 0.101$, 95 % CI [-1.146, 1.347]).

4. Discussion

The study explored differences in cognitive function between aging sexual minority and heterosexual adults in Canada based on a national survey of the aging population. Looking at the direct effects of sexual orientation on cognitive outcome variables (cognitive flexibility and verbal fluency), aging gay men reported higher levels of cognitive flexibility compared to aging heterosexual men. Although indirect effects were not statistically significant, models with social participation as a mediator indicated that sexual orientation negatively impacts cognition because gay men have lower levels of social participation compared to their heterosexual counterparts. Total effects indicate that aging gay men still report higher levels of cognitive performance for cognitive flexibility-related tasks despite the consideration of indirect effects of social support and social participation considered in each model. Our finding suggests that mediating effects of social support and social participation were not large enough to significantly impact cognitive outcomes of aging gay men. Previous studies of aging sexual minority adults have identified that aging gay men are at higher risk of social isolation due to the relative lack of biological family members, and such isolation can contribute to poor health outcomes including mental and cognitive health (Fredriksen-Goldsen, 2011; Wallace, Cochran, Durazo, & Ford, 2011). Conversely, a national community-based survey in Australia reported a positive relationship between social support and mental health outcomes in aging gay men (Lyons, 2016). Even though our study's findings regarding social participation align with these studies, the effects of the mediator were not statistically significant to contribute to the overall cognitive health outcomes. Moreover, our results regarding higher cognitive flexibility for aging gay men compared to their heterosexual counterparts point to other potential areas of exploration. Such finding reflects the opposite of what Corroero and Nielson (2020) suggested through their theoretical perspective, which was also informed by the minority stress model. As Meyer's minority stress model (2003) suggests the role of individual and community coping, aging gay men's resiliency that was developed

throughout their adolescence and adulthood would have contributed to their increased level of cognitive flexibility. Hence, the role of resilience may have larger influence on cognitive health in aging gay men. Future studies could explore the role of coping and resiliency in order to better understand their influences on cognitive aging in sexual minority people.

Aside from our unexpected findings, our results from the comparison between aging heterosexual and lesbian women indicated that social support significantly influences the relationship between homosexuality and cognition. Aging lesbian adults reported positive indirect effects in both cognitive measures in our study when considering social support as a result of the significantly higher perceived social support levels among lesbians compared to their heterosexual counterparts. Qualitative data from a study that investigated loneliness among sexual and gender minority adults that are over the age of 50 showed that aging lesbian women have supportive children from their previous heterosexual marriage and receive social support from their current partner (Hughes, 2016). Therefore, such access to both biological family and chosen family may have a more robust impact on aging lesbian women's cognitive health. Furthermore, there was no significant indirect effect of social participation among aging women when considering cognitive performance between aging lesbian and heterosexual women. Such finding is aligned with a previous study that was conducted by Hsieh et al. (2021) regarding the role of social connection in the relationship between sexual orientation and cognition. It found that social connection, which included community participation rate, was not a statistically significant mediator (Hsieh et al., 2021). However, the study did not differentiate lesbian, gay, and bisexual adults separately due to limited number of sexual minority people in the sample.

Our findings build upon previous studies that examined cognitive differences between aging sexual minority and heterosexual adults (Brown & Patterson, 2020; Hsieh et al., 2021). Hsieh et al. (2021) reported that aging sexual minority adults have a higher risk of cognitive decline relative to heterosexual people, which is not consistent with some of our findings related to aging sexual minority people. Such difference could be the result of our study's use of gender stratification, which allowed us to explore aging men and aging women separately by sexual orientation. This was possible by having a large sample size that was provided by a national scale survey. Moreover, sexual orientation groups were separated into three groups in our study compared to studies that had to combine all sexual minority groups (Hsieh et al., 2021). Our findings align with Stinchcombe & Hammond's, 2022 study that also utilized the CLSA's data to explore aging minority populations' cognition. Stinchcombe and Hammond (2022) reported higher cognitive function for sexual minority adults while considering a variety of correlates, including social support, in their regression models. Our study further investigates these interesting results by examining the influence of an additional social factor, social participation, on the cognitive outcomes of sexual minority populations.

Overall, our findings point to the importance of continuous research on sexual orientation and cognition as well as the impact of available social resources on cognitive health in aging minority populations, which aging sexual minority adults often lack due to their lower likelihood of having a long-term partner and/or children through marriage (Shankle et al., 2003; Guasp, 2011). A theoretical paper by Corroero and Nielson (2020) proposed social support as a protective factor for cognition in the aging sexual minority population. Our findings suggest the expansion of the components in minority stress model is warranted to further understand sexual minority health because only social support is included as a mediating factor in the framework (Meyer, 2003), and our results reveal that social support and social participation are not significant mediators that can explain higher cognitive performance scores that were observed in gay men and bisexual women when compared to their heterosexual peers. Therefore, our findings suggest that future research should explore other mechanisms such as coping strategies and resiliency, which may act as protective factors related to

sexual minority aging.

Our study has some limitations to be taken into account when interpreting our findings. Although the current study had a large sample size, only about 2 % of the sample identified as sexual minorities. Therefore, the opportunity to oversample sexual minority aging adults in future waves of population survey would lead to more robust insights. Given the nature of the available survey data, our gender analyses were binary and could only consider the categories of men and women. As a result, non-binary individuals who participated in the survey may have been excluded during the data cleaning process because they had an option to not answer the question regarding gender. Further integration of sex and gender into analyses with the consideration of gender diversity for future studies would generate more inclusive information. In addition, sexual orientation only provided three choices for respondents to choose from: homosexual; bisexual; and heterosexual. If respondents did not identify as any of these sexual orientation group, they had the option to decline to answer the question. This rigid categorization of sexual identities can pose barriers in furthering insights on people with even more marginalized identities such as pansexual and asexual people. Therefore, future research studies should incorporate a wider variety of sexual orientation. Furthermore, including other key variables such as physical and mental health status as well as social network size as additional predictors would provide a more comprehensive understanding regarding sexual minority aging. Moreover, the current study only included two cognitive measures from the CLSA data in order to conduct our analyses with a larger sample size. Future studies that utilize the CLSA data could include more cognitive measures, such as the STROOP neuropsychological screening test, that were facilitated during the in-person site visit when investigating aging and cognition.

5. Conclusion

Our results indicate that social support is an important protective factor for the cognitive health of aging sexual minority individuals. In sexual minority women, aging lesbians showed significant indirect effect of sexual minority status on cognitive task via social support when compared to heterosexual women after accounting for control variables (education, income, age, and relationship status). Hence, future programming for cognitive health should consider how sexual identity can impact cognition while considering ways to boost social support to maintain the aging population's well-being. Moreover, LGBTQ+ organizations could explore allocating more resources towards events and services that can increase aging sexual minority people's social activities in order to prevent cognitive decline within the community.

The study also demonstrated the role of social participation when considering differences in cognitive performance between aging gay and heterosexual men as well as aging lesbian and heterosexual women. Although the significant effects of social participation were not found in our study, the negative trend of social participation level's mediating effect highlights the vulnerability of aging gay men and lesbian women in relation to their social engagement and cognition. Further outreach efforts to facilitate social participation of aging sexual minority people by providing spaces without barriers generated by ageism and/or heterosexism should be considered in order to increase the level of cognitive well-being of this group. Based on the results of this study, efforts to increase competency related to building sexual minority friendly care for aging related services is essential since there are concerns related to cognitive decline in this population that is often neglected in conversations around dementia care needs (Fredriksen-Goldsen et al., 2016; Wilson, Stinchcombe, Ismail, & Kortess-Miller, 2019). Therefore, our study's findings can help to support program development opportunities to maintain sexual minority people's cognitive health as they age.

CRedit authorship contribution statement

Wook Yang: Conceptualization, Formal analysis, Investigation,

Methodology, Writing – original draft, Writing – review & editing. **Shelley L. Craig:** Conceptualization, Supervision. **John A.E. Anderson:** Methodology, Supervision. **Lori E. Ross:** Conceptualization, Supervision. **Carles Muntaner:** Supervision.

Declaration of competing interest

This is an original article and it is not being considered for publication elsewhere. None of the authors has a conflict of interest with regard to the work.

Data availability

Data are available from the Canadian Longitudinal Study on Aging (www.clsa-elcv.ca) for researchers who meet the criteria for access to

de-identified CLSA data.

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Appendix 1. Correlations of covariates, mediators, and outcome variables: aging men (r values)

	Age	Relationship	Education	Income	Social Participation	Social Support	Cognitive Flexibility	Verbal Fluency
Age	1 [*]	0.072 [*]	−0.138 [*]	−0.300 [*]	0.038 [*]	−0.022 [*]	−0.237 [*]	−0.334 [*]
Relationship	0.072 [*]	1 [*]	−0.021 [*]	−0.130 [*]	−0.042 [*]	−0.168 [*]	−0.028 [*]	−0.030 [*]
Education	−0.138 [*]	−0.021 [*]	1 [*]	0.277 [*]	0.157 [*]	0.074 [*]	0.209 [*]	0.183 [*]
Income	−0.300 [*]	−0.130 [*]	0.277 [*]	1 [*]	0.186 [*]	0.255 [*]	0.254 [*]	0.255 [*]
Social Participation	0.038 [*]	−0.042 [*]	0.157 [*]	0.186 [*]	1 [*]	0.238 [*]	0.091 [*]	0.077 [*]
Social Support	−0.022 [*]	−0.168 [*]	0.074 [*]	0.255 [*]	0.238 [*]	1 [*]	0.099 [*]	0.102 [*]
Cognitive Flexibility	−0.237 [*]	−0.28 [*]	0.209 [*]	0.254 [*]	0.091 [*]	0.099 [*]	1 [*]	0.363 [*]
Verbal Fluency	−0.334 [*]	−0.30 [*]	0.183 [*]	0.255 [*]	0.077 [*]	0.102 [*]	0.363 [*]	1 [*]

^{*} Indicates statistical significance ($p < 0.05$).

Appendix 2. Correlations of covariates, mediators, and outcome variables: aging women (r values)

	Age	Relationship	Education	Income	Social Participation	Social Support	Cognitive Flexibility	Verbal Fluency
Age	1 [*]	0.173 [*]	−0.189 [*]	−0.300 [*]	0.070 [*]	−0.103 [*]	−0.261 [*]	−0.347 [*]
Relationship	0.173 [*]	1 [*]	−0.062 [*]	−0.130 [*]	−0.020 [*]	−0.159 [*]	−0.065 [*]	−0.071 [*]
Education	−0.189 [*]	−0.062 [*]	1 [*]	0.277 [*]	0.180 [*]	0.048 [*]	0.186 [*]	0.229 [*]
Income	−0.397 [*]	−0.281 [*]	0.289 [*]	1 [*]	0.138 [*]	0.256 [*]	0.235 [*]	0.275 [*]
Social Participation	0.070 [*]	−0.020 [*]	0.180 [*]	0.138 [*]	1 [*]	0.204 [*]	0.080 [*]	0.087 [*]
Social Support	−0.103 [*]	−0.159 [*]	0.048 [*]	0.256 [*]	0.204 [*]	1 [*]	0.091 [*]	0.096 [*]
Cognitive Flexibility	−0.261 [*]	−0.065 [*]	0.186 [*]	0.235 [*]	0.080 [*]	0.091 [*]	1 [*]	0.356 [*]
Verbal Fluency	−0.347 [*]	−0.071 [*]	0.229 [*]	0.275 [*]	0.087 [*]	0.096 [*]	0.356 [*]	1 [*]

^{*} Indicates statistical significance ($p < 0.05$).

Appendix 3. Model coefficients for cognitive flexibility with social support as a mediator, men.

Antecedent	Consequent							
	M (Social Support)				Y (Cognitive Flexibility)			
		Coeff.	SE	p		Coeff.	SE	p
X ₁ (Gay)	a ₁	1.601	0.770	0.038	c' ₁	0.936	0.420	0.026
X ₂ (Bisexual)	a ₂	0.951	1.551	0.540	c' ₂	1.018	0.846	0.229
M					b	0.026	0.004	<0.001
C ₁ (Age)	f ₁	0.047	0.011	<0.001	g ₁	−0.153	0.006	<0.001
C ₂ (Education)	f ₂	0.357	0.126	0.005	g ₂	1.446	0.069	<0.001
C ₃ (Income)	f ₃	2.056	0.116	<0.001	g ₃	1.337	0.064	<0.001
C ₄ (Relationship)	f ₄	17.132	0.296	<0.001	g ₄	−0.277	0.174	0.111
Constant	i _M	40.282	1.032	<0.001	i _Y	25.486	0.583	<0.001
		R ² = 0.196				R ² = 0.114		
		F(6, 21,334) = 868.655, p < 0.001				F(7, 21,333) = 391.644, p < 0.001		

Antecedent	Consequent							
	M (Social Participation)				Y (Cognitive Flexibility)			
		Coeff.	SE	p		Coeff.	SE	p
X ₁ (Gay)	a ₁	−0.345	0.214	0.106	c' ₁	1.013	0.420	0.016
X ₂ (Bisexual)	a ₂	−0.038	0.430	0.930	c' ₂	1.047	0.846	0.216
M					b	0.101	0.013	<0.001
C ₁ (Age)	f ₁	0.047	0.011	<0.001	g ₁	−0.156	0.006	<0.001
C ₂ (Education)	f ₂	0.611	0.035	<0.001	g ₂	1.394	0.069	<0.001
C ₃ (Income)	f ₃	0.647	0.032	<0.001	g ₃	1.325	0.064	<0.001
C ₄ (Relationship)	f ₄	0.821	0.082	<0.001	g ₄	0.087	0.162	0.590
Constant	i _M	2.684	0.286	<0.001	i _Y	26.266	0.564	<0.001
		R ² = 0.060				R ² = 0.114		
		F(6, 21,334) = 227.853, p < 0.001				F(7, 21,333) = 392.813, p < 0.001		

Appendix 5. Model coefficients for verbal fluency with social support as a mediator, men.

Antecedent	Consequent							
	M (Social Support)				Y (Verbal Fluency)			
		Coeff.	SE	p		Coeff.	SE	p
X ₁ (Gay)	a ₁	1.530	0.749	0.041	c' ₁	0.152	0.248	0.541
X ₂ (Bisexual)	a ₂	−0.612	1.513	0.686	c' ₂	−0.622	0.501	0.214
M					b	0.021	0.002	<0.001
C ₁ (Age)	f ₁	0.046	0.011	<0.001	g ₁	−0.156	0.004	<0.001
C ₂ (Education)	f ₂	0.427	0.123	0.001	g ₂	0.661	0.041	<0.001
C ₃ (Income)	f ₃	1.990	0.114	<0.001	g ₃	0.711	0.038	<0.001
C ₄ (Relationship)	f ₄	17.256	0.290	<0.001	g ₄	−0.352	0.103	0.001
Constant	i _M	40.123	1.009	<0.001	i _Y	23.884	0.346	<0.001
		R ² = 0.197				R ² = 0.152		
		F(6, 22,324) = 910.845, p < 0.001				F(7, 22,323) = 569.968, p < 0.001		

Appendix 6. Model coefficients for verbal fluency with social participation as a mediator, men.

Antecedent	Consequent							
	M (Social Participation)				Y (Verbal Fluency)			
		Coeff.	SE	p		Coeff.	SE	p
X ₁ (Gay)	a ₁	−0.375	0.208	0.072	c′ ₁	0.206	0.248	0.407
X ₂ (Bisexual)	a ₂	0.064	0.420	0.880	c′ ₂	−0.639	0.501	0.202
M					b	0.061	0.008	<0.001
C ₁ (Age)	f ₁	0.046	0.003	<0.001	g ₁	−0.158	0.004	<0.001
C ₂ (Education)	f ₂	0.620	0.034	<0.001	g ₂	0.632	0.041	<0.001
C ₃ (Income)	f ₃	0.651	0.032	<0.001	g ₃	0.712	0.038	<0.001
C ₄ (Relationship)	f ₄	0.823	0.081	<0.001	g ₄	−0.045	0.096	0.642
Constant	i _M	2.630	0.280	<0.001	i _Y	24.554	0.335	<0.001
		R ² = 0.061				R ² = 0.151		
		F(6, 22,324) = 242.015, p < 0.001				F(7, 22,323) = 565.065, p < 0.001		

Appendix 7. Model coefficients for cognitive flexibility with social support as a mediator, women.

		Consequent						
		M (Social Support)			Y (Cognitive Flexibility)			
Antecedent		Coeff.	SE	p		Coeff.	SE	p
X ₁ (Lesbian)	a ₁	3.088	0.952	0.001	c' ₁	−0.398	0.567	0.483
X ₂ (Bisexual)	a ₂	−0.611	1.593	0.701	c' ₂	0.124	0.881	0.888
M					b	0.021	0.004	<0.001
C ₁ (Age)	f ₁	0.037	0.012	0.003	g ₁	−0.163	0.006	<0.001
C ₂ (Education)	f ₂	−0.164	0.128	0.149	g ₂	1.048	0.066	<0.001
C ₃ (Income)	f ₃	2.145	0.122	<0.001	g ₃	0.975	0.064	<0.001
C ₄ (Relationship)	f ₄	8.703	0.266	<0.001	g ₄	−0.328	0.138	0.017
Constant	i _M	59.774	1.141	<0.001	i _Y	28.397	0.611	<0.001
		R ² = 0.113				R ² = 0.102		
		F(6, 21,439) = 247.786, p < 0.001				F(7, 21,438) = 338.545, p < 0.001		

Appendix 8. Model coefficients for cognitive flexibility with social participation as a mediator, women.

Antecedent	Consequent				Y (Cognitive Flexibility)			
	M (Social Participation)				Y (Cognitive Flexibility)			
		Coeff.	SE	p		Coeff.	SE	p
X_1 (Lesbian)	a_1	−0.418	0.254	0.099	c'_1	−0.283	0.566	0.616
X_2 (Bisexual)	a_2	0.592	0.435	0.173	c'_2	0.042	0.871	0.962
M					b	0.116	0.013	<0.001
C_1 (Age)	f_1	0.076	0.003	<0.001	g_1	−0.171	0.006	<0.001
C_2 (Education)	f_2	0.821	0.036	<0.001	g_2	0.949	0.067	<0.001
C_3 (Income)	f_3	0.617	0.034	<0.001	g_3	0.950	0.064	<0.001
C_4 (Relationship)	f_4	0.044	0.073	0.544	g_4	−0.147	0.134	0.273
Constant	i_M	2.457	0.301	<0.001	i_Y	29.389	0.568	<0.001
		$R^2 = 0.064$				$R^2 = 0.104$		
		$F(6, 21,439) = 229.982, p < 0.001$				$F(7, 21,438) = 343.082, p < 0.001$		

Appendix 9. Model coefficients for verbal fluency with social support as a mediator, women.

Antecedent	Consequent				Y (Verbal Fluency)			
	M (Social Support)				Y (Verbal Fluency)			
		Coeff.	SE	p		Coeff.	SE	p
X_1 (Lesbian)	a_1	3.122	0.946	0.001	c'_1	0.232	0.342	0.485
X_2 (Bisexual)	a_2	−1.028	1.604	0.522	c'_2	0.297	0.516	0.565
M					b	0.013	0.002	<0.001
C_1 (Age)	f_1	0.035	0.012	0.003	g_1	−0.152	0.004	<0.001
C_2 (Education)	f_2	−0.163	0.126	0.196	g_2	0.832	0.037	<0.001
C_3 (Income)	f_3	2.179	0.120	<0.001	g_3	0.676	0.039	<0.001
C_4 (Relationship)	f_4	8.761	0.261	<0.001	g_4	−0.395	0.084	<0.001
Constant	i_M	59.576	1.124	<0.001	i_Y	23.758	0.368	<0.001
		$R^2 = 0.115$				$R^2 = 0.162$		
		$F(6, 22,369) = 420.284, p < 0.001$				$F(7, 22,368) = 657.683, p < 0.001$		

Appendix 10. Model coefficients for verbal fluency with social participation as a mediator, women.

Antecedent	Consequent				Y (Verbal Fluency)			
	M (Social Participation)				Y (Verbal Fluency)			
		Coeff.	SE	p		Coeff.	SE	p
X_1 (Lesbian)	a_1	−0.464	0.262	0.077	c'_1	0.313	0.340	0.357
X_2 (Bisexual)	a_2	0.666	0.437	0.128	c'_2	0.227	0.513	0.658
M					b	0.085	0.008	<0.001
C_1 (Age)	f_1	0.075	0.003	<0.001	g_1	−0.158	0.004	<0.001
C_2 (Education)	f_2	0.809	0.035	<0.001	g_2	0.761	0.038	<0.001
C_3 (Income)	f_3	0.616	0.033	<0.001	g_3	0.652	0.039	<0.001
C_4 (Relationship)	f_4	0.066	0.071	0.356	g_4	−0.285	0.082	0.001
Constant	i_M	2.497	0.296	<0.001	i_Y	24.332	0.339	<0.001
		$R^2 = 0.063$				$R^2 = 0.102$		
		$F(6, 22,369) = 236.174, p < 0.001$				$F(7, 21,438) = 338.545, p < 0.001$		

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