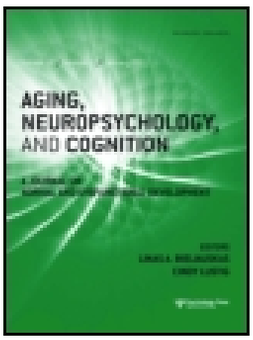

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Age, executive functioning, and decision-making styles in adults: a moderated mediation model

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ABSTRACT

The current study aimed to assess: i) whether executive functioning (EF) mediates the association of age with different decision-making (DM) styles in adults, and ii) whether these mediational associations change with age in adulthood. Our sample included 195 adults (110 young adults and 85 middle-aged adults; 95 males) selected from different government, semi-government, and private sector organizations. They were assessed on a self-report measure of General Decision-making Styles and on two EF tests: the Design Fluency Test and the Color-Word Interference Test from the Delis–Kaplan Executive Functions System. Results indicated that EF mediated the association of age with three decision-making styles including dependent, avoidant, and spontaneous DM. However, a conditional indirect effect of EF was significant only for spontaneous DM, indicating stronger indirect effects for middle-aged adults than for young adults. The findings highlight the idea that EF is an important factor in DM, particularly during middle adulthood.

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Age; executive functioning; decision-making; young adults; middle-aged adults

Adulthood is the period in which full physical maturity has been attained, and psychological markers such as accepting responsibility for one's self and making independent decisions have been reached (Arnett, Žukauskienė, & Sugimura, 2014). Adulthood is commonly considered to begin at age 20 or 21 (for some, it starts at age 18; Arnett et al., 2014). Middle age, commencing at about 45 years, is followed by old age at about 60 years (American Psychiatric Association, 1994). Young and middle-aged adults make up the majority of the world population (Population Reference Bureau, 2018) and they experience circumstances which demand them to make decisions related to their personal and family life. Therefore, understanding the influence that age may have in decision-making (DM) and its cognitive underpinnings in young and middle adulthood are critical. The present study analyzed the association of age with DM styles as mediated by executive function (EF) in young and middle adulthood. Although several studies have assessed DM in samples of older adults as well as in adolescents and university students (Chen & Sun, 2003; Del Missier, Mäntylä, & Bruine de Bruin, 2010; Hess, Queen, & Ennis, 2012), little

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research is found comparing DM in young and middle-aged adults, despite evidence showing that an individual's brain and neurocognitive skills do not remain fixed across these stages (Bryan & Luszcz, 2000; Petrican, Taylor, & Grady, 2017).

Scott and Bruce (1995) defined DM processes as "the learned, habitual response pattern exhibited by an individual when confronted with a decision situation" (p.832). The authors described five DM styles: 1) rational style (using systematic assessment and logical analyses of options); 2) intuitive style (relies on feeling and hunches); 3) dependent style (looking for an advice and direction from others); 4) avoidant style (trying to avoid decision-making); and 5) spontaneous style (making decision quickly and immediately without searching for detail). Additional types of decision processes have been identified (Frankish & Evans, 2009). One of which is consciously deliberated, involving strategies that are rule-based and controlled, and which involve effortful cognition (e.g., working memory and executive control). The second decision process is intuitive and impulsive and is based on quick reactions to stimuli guided by automatic responses connected to associative and emotional stimuli.

Decision-making is a cognitive process resulting in the selection of a favored choice or a course of action among several possibilities on the basis of given criteria or strategy (Wang & Ruhe, 2007). This process is considered an EF, suggesting that it is related to an individual's ability to monitor, regulate, and control cognition and behavior when choosing among multiple options. Del Missier et al. (2010) evaluated young adults and found that the successful application of decision rules required the capacity to selectively focus attention and inhibit irrelevant information.

Decision-making processes are modulated by the age of the decision-maker. For example, the ability to make real-world decisions declines in some older adults (Denburg, Tranel, & Bechara, 2005). Moreover, adults (18–85 years) tend to take lower risks in the gain domain when compared with children (5–11 years) in the Cups Task, designed to assess risk preferences through choices made in a game (Levin & Hart, 2003; Weller, Levin, Denburg, & Irwin, 2011). However, age effects on DM under risk and ambiguity as measured by the Iowa Gambling Task have shown contradictory results (see Brand & Markowitsch, 2010). Some authors found negative effects of higher age on DM (Denburg et al., 2005; Fein, McGillivray, & Finn, 2007; Zamarian, Sinz, Bonatti, Gamboz, & Delazer, 2008), while others reported very small or no age effects (Henninger, Madden, & Huettel, 2010).

Using cluster-analysis, Delaney, Strough, Parker, and de Bruin (2015) investigated whether rational, intuitive, spontaneous, dependent, and avoidant styles of DM proposed by Scott and Bruce (1995) may work together, resulting in DM profiles that differ according to age and gender. Self-report survey data were collected from 1,075 members of RAND's American Life Panel. Three DM profiles were disclosed. Older individuals were less likely to present an affective/experiential profile and more likely to have an independent/self-controlled profile. Women were less likely to have an affective/experiential profile and more likely to have an interpersonally oriented dependent profile.

Beyond changes in the preferred DM process, age-related changes in DM styles and decision competence may also depend on the task, level of cognitive effort involved, and strategies used to analyze options and utilize available resources to reach a decision. For example, evidence suggests that older adults prefer to rely on satisficing, a heuristic processing strategy limited to analyzing only sufficient and necessary information aimed at adequate rather than optimal decisions (Chen & Sun, 2003; Peters, 2010;

Schwartz et al., 2002; Yoon, Feinberg, & Schwarz, 2010). On the other hand, young adults are inclined to use more systematic, cognitive, and maximizing strategies in DM. Presumably, older adults adopt satisficing to easily manage the decision process in order to decrease cognitive efforts (Hess et al., 2012). Conversely, it is argued that when decision makers are knowledgeable and self-relevance of the decision task is high, decision strategies may be similar for young and older adults (Hess et al., 2012; Queen, Hess, Ennis, Dowd, & Grühn, 2012).

Age-related preferences in DM strategies may be attributed to basic cognitive processing skills and higher EF. Evidence shows that DM can be influenced by several EF such as planning, working memory, attention, inhibition, mental flexibility, and multitasking (Chan, Shum, Toulopoulou, & Chen, 2008; Elliott, 2003). The association between DM and EF has been tested in individuals suffering from diverse pathological conditions such as gambling disorder, conduct disorder, and attention deficit hyperactivity disorder, but very little is known about this association in normal samples. Among the few studies conducted with healthy participants, Schiebener et al. (2014) found that three EFs, cognitive self-control, concept formation, and monitoring, explained approximately 14–15% of the variance in DM, with cognitive self-control being the strongest predictor.

Age-related alterations in cognitive skills may substantially influence how adults' DM styles may change across adulthood. Cognitive abilities, including subcomponents of EF such as cognitive flexibility as assessed by the Wisconsin Card Sorting Test (WCST), verbal and nonverbal fluency, inhibitory control as measured by the Stroop task, and working memory, show clear age-related declines (Elderkin-Thompson, Ballmaier, Hellemann, Pham, & Kumar, 2008; Peng, Gao, & Mao, 2017; Rypma, Prabhakaran, Desmond, & Gabrieli, 2001).

Recently, the relationships between age and EF, and EF and DM, have become the focus of researchers (Brand & Schiebener, 2013; Bruine de Bruin, Parker, & Fischhoff, 2012; Del Missier et al., 2010) however, the mediational links between age-EF-DM styles is an area that requires additional attention. Accordingly, Bruine de Bruin et al. (2012) reported that compared to young adults, old adults performed worse on two decision competence tasks (i.e., Applying Decision Rules and Resistance to Framing). Also, these researchers found that fluid cognitive ability mediated these associations. Further, Brand and Schiebener (2013) found that age was significantly related to performance on the Game of Dice Task in a sample of 538 healthy adults (18–80 years of age). Moreover, they showed that this relationship was moderated by subcomponents of EF and logical thinking, with older adults with higher EF performing better on the task compared to older adults with reduced EF.

Given that previous research suggests that there are age differences in DM and EF and that EF plays an important role in DM processes, the current study hypothesized that EF would mediate the association between age and DM styles. Most importantly, mediational links between age, EF, and DM styles are likely to change across the developmental stages of adulthood, given that the speed of age-related declines in EF may not be similar across adulthood, leading to differential cognitive explanations of the age-DM link for young and middle-aged adults. Therefore, it was also hypothesized that the meditational relations between age, EF, and DM styles would differ for young and middle-aged adults. The current study used a nonverbal speed task that assessed planning and cognitive flexibility as well as an inhibitory task. To our knowledge, Scott

and Bruce's (1995) DM styles have not been tested across a large age range of healthy participants and have not been assessed in relation to EF, particularly moderated by adulthood.

Method

Participants

The sample was recruited from private and public sector organizations of Lahore. Lahore is the second largest cosmopolitan city in Pakistan, and the fifth largest city in South Asia and is inhabited by more than ten million people from diverse backgrounds. Inclusion criteria for participants were as follows: ages ranging from 30 to 60, a minimum of an undergraduate level of education, and being employed (in private, government, or semi-government organizations and institutions). Exclusion criteria included a history of brain injury, neuropsychological or psychiatric disorders, or the presence of any aging disorder.

Initially, the researchers contacted 244 participants, 49 were excluded for the following reasons: meeting the exclusion criteria (10%), not volunteering for research (5%), and not responding to all study measures (6%). One-hundred and ninety-five participants were included in the final sample.

Participants' ages ranged from 30 to 59 years (M_{age} = 43.82, SD = 8.67), and all reported a South Asian ethnic background. The sample was divided into two age groups: young adults (age range: 30 to 44, M = 37.35, SD = 5.15, n = 110) and middle-aged adults (age range: 45–59, M = 52.20, SD = 3.65, n = 85) in accordance with DSM-IV criteria of adulthood stages (American Psychiatric Association, 1994). The sample was fairly distributed across two age groups in terms of gender, employment sector, and educational status. The demographic characteristics of the sample across two age groups are shown in Table1.

Materials and procedure

Executive function

Executive Function (EF) was assessed with two tasks: Color-Word Interference Test (CWIT) and Design Fluency Test (DFT) from the Delis–Kaplan Executive Function System (DKEFS; Delis, Kaplan, & Kramer, 2001). The CWIT consists of four conditions. The first two conditions (CWIT 1andCWIT 2) assess basic cognitive functions, such as primary visual,

Table 1. Percentages of demographics across two age groups and significance of group differences.

Variable	Categories	Full sample	Young adults	Middle-aged adults	Test of significance
Gender	Male	49	51	46	Mann Whitney U test = 4515, p > .05
	Female	51	49	54	
Employment sector	Private	37	43	31	Kruskal Wallis test = 3.58, p > .05
	Public	34	33	36	
	Semi Government	29	28	30	
Education	Undergraduate	37	35	39	Kruskal Wallis test = 3.21, p > .05
	Graduate	34	35	33	
	Professional degrees	29	30	28	

perceptual, and linguistic abilities. On the CWIT1, participants were asked to name basic colors, and on the CWIT 2, participants read the color words printed in black ink. Conditions 3 (CWIT3) and 4 (CWIT4) assessed higher EF abilities, such as cognitive control by assessing inhibition, conflict monitoring, and cognitive switching. The CWIT3 involves naming the ink color while inhibiting and ignoring the well-learned response of reading (the word is printed in mismatched ink color, e.g., the word "blue" is printed in green ink). The CWIT4 assesses cognitive flexibility or switching. The respondent is required to switch between reading the words which are outlined in the box and naming the ink color for words which are not in the box. Completion time (T) and the number of errors (E) on all conditions were noted, with higher scores representing poorer EF.

Design fluency test

The Design Fluency Test (DFT; Delis et al., 2001) requires the examinee to draw different designs by using four lines in three conditions: basic, filter, and switch. In condition 1 (basic, DFT1), the respondent is required to draw different designs by joining filled dots. Condition 2 (filter, DFT2) assesses conflict monitoring by ignoring filled dots and joining only the empty dots to draw different designs. Condition 3 (switch, DFT3) assesses cognitive flexibility by switching between filled and empty dots to draw different designs. Each condition is preceded by a practice session. The number of correctly generated designs was noted in each condition, with higher scores representing better EF. The psychometric properties of the CWIT and the DFT have been reported to be adequate (Delis et al., 2001).

General decision-making style

The General Decision-making Style scale (GDMS; Scott & Bruce, 1995) assesses different DM styles an individual uses while deciding about different conflicting life situations and routine matters. It contains five DM style subscales: rational, intuitive, dependent, avoidant, and spontaneous. The scale includes 25 items, and each subscale is assessed with 5 items. All items are rated on a 5- point Likert scale (from 1 = strongly disagree to 5 = strongly agree). A composite score was calculated by adding the scores on items comprising each subscale. Alpha reliability coefficients for the subscales were very good (.89 to .91).

Procedure

Ethical approval from Institutional Research Review Committee COMSATS University Lahore was obtained. Potential participants were approached in different organizations and informed about the study and its inclusion and exclusion criteria. Ethical considerations were followed during data collection. Participants were assured of the confidentiality of their responses and their privacy was maintained. They were informed of their right to withdraw from the study at any point if they opted to do so. There were no benefits to participating in the study. After obtaining their consent, they were administered the four conditions of the CWIT, the three conditions of the DFT, and the GDMS in an individual setting. The order of the assessment measures was counterbalanced across participants to control for any potential order effect. We ensured that participation in the study would not cause physical or emotional harm to the participants. Their queries

regarding this research were also answered. The study measures were administered by a neuropsychologist and a psychologist.

Preliminary data analyses

The data were checked and corrected for coding errors and outliers. During missing data analyses, it was found that none of the variables had more than 3% of missing data, which were handled with single imputation method.

Given that the DKEFS tests are normed on Western cultures and these norms are not necessarily applicable to South Asians, the raw scores on conditions of the CWIT and the DFT were used in data analyses. Considering that higher scores (greater completion time and more errors) on the CWIT represent lower EF, while higher scores (greater number of correct designs) on the DFT represent better EF, scores on the CWIT were reverse scored. Then, reverse completion time and reverse number of error scores on the four conditions of the CWIT and direct scores (number of correct completed designs) on the three conditions of the DFT were standardized ($M = 0$, $SD = 1$). To calculate the composite EF score, standardized scores on the CWIT (completion time and number of errors) and the DFT were added, with a higher score representing well-developed EF. The internal consistency of EF scores in the current study was .78, suggesting that all measures assessed a unitary underlying construct, that is, EF.

Data analysis strategy

Descriptive statistics were computed for study variables (means, standard deviations, and alpha reliabilities) for young and middle-aged adults. The t-tests compared young and middle-aged adults on all EF measures. Then, Pearson correlations were calculated between study variables for the full sample as well as for both age groups separately.

Finally, to assess mediation models and moderated mediation models, the Process software was used (Preacher & Hayes, 2008). Because Process gives unstandardized regression weights, prior to testing the mediation and moderated mediation models through regression analyses, raw scores for all the study variables were standardized with $M = 0$ and $SD = 1$. Additionally, 5000 bias-corrected bootstrapped samples were generated for testing these models. To test the mediation models and assess the direct and indirect relations between age, EF, and DM styles, the data were first analyzed using Model 4 in Process. Model 4 provides regression weights for total, direct, and indirect effects as well as the significance of indirect effects by assessing Sobel z-test. Next, the data were analyzed using moderated mediation analyses with EF as a mediator of the age-DM style link, and adulthood stage (2 levels: young and middle-aged adults) as a moderator of the EF-DM style link using Model 14 in Process. Model 14 provides the significance of the interaction term as well as conditional indirect effects of the mediator across levels of moderator. The same approach to mediation and moderated mediation were repeated for all five DM styles.

Results

Means, standard deviations, and alpha reliabilities of study variables were calculated and are presented in Tables 2 and 3. Table 2 shows the high-reliability coefficients for the DM

Table 2. Descriptive statistics of the executive functions variables by age groups.

	Young Adults (N = 110)			Middle-Age Adults (N = 85)			
Measures	M	SD	Range	M	SD	Range	*t*
CWIT1(T)	31.90	5.60	9–47	35.31	11.12	23–60	−2.78*
CWIT2(T)	21.09	3.98	15–35	20.69	3.72	14–33	.71
CWIT3(T)	55.99	12.14	13–87	63.22	23.11	28–112	−2.82*
CWIT4(T)	59.68	11.89	42–98	62.48	16.20	30–92	−1.39
CWIT1(E)	1.17	1.43	0–5	2.14	3.00	0–9	−2.97*
CWIT2(E)	.42	.93	0–4	.32	.58	0–2	.77
CWIT3(E)	3.95	2.82	0–15	4.04	2.61	0–15	−.20
CWIT4(E)	4.30	2.87	0–16	4.31	2.79	0–12	−.04
DFT1	9.99	4.45	0–20	8.35	4.77	0–21	2.47
DFT2	10.63	4.79	0–22	9.30	4.48	0–21	1.98
DFT3	6.91	4.02	0–18	5.05	3.93	0–16	3.22*

* = $p < .01$; CWIT = Color-Word Interference Test; T = time; E = errors; DFT = Design Fluency Test; after using Bonferroni correction for multiple comparisons, the p-value was set to .0045.

Table 3. Descriptive statistics of decision-making styles.

	Full Sample (N = 195)	Young Adults (*n* = 110)			Middle-Aged Adults(*n* = 85)		
Measures	α	M	SD	Range	M	SD	Range
Rational DM	.89	16.11	4.58	6–24	15.69	4.50	6–24
IntuitiveDM	.85	16.71	3.80	6–22	17.05	3.86	6–23
Dependent DM	.91	16.75	4.16	6–24	17.51	4.38	6–24
Avoidant DM	.92	14.58	4.40	6–24	15.51	5.45	6–24
Spontaneous DM	.90	14.62	3.61	6–22	13.62	4.39	6–22

DM = Decision-making; df for t-test analyses were 193 for all decision-making outcomes.

subscales, ranging from .89 to .92. Moreover, t-tests were conducted to assess age differences between young and middle adults on EF measures. The results showed significant differences between two age groups on the CWIT (completion time of condition 1 and 3, and errors on condition 1) and the DFT (condition 3).

Correlations between age, EF, and different DM styles were calculated for the full sample as well as for the two age groups (see Table 4). In the entire sample, age was positively correlated with dependent and avoidant DM and was negatively correlated with spontaneous DM and EF. On the other hand, EF was positively correlated with rational and spontaneous DM but negatively correlated with dependent and avoidant DM (in the full sample). The correlations between age groups (Table 5) revealed stronger associations for middle-aged adults with the test variables compared to young adults.

Mediation models were calculated to assess the mediating effect of EF in relation to age and DM styles using Model 4 (see Table 5 and Figure 1). Model 4 provides the significance of the mediation effect as well as total, direct, and indirect effects. The results from the mediation analyses revealed that EF significantly mediated the link of age with three DM styles. Finally, when moderated mediation models were analyzed using Model 14 to assess the conditional indirect effects of EF for young and middle-aged adults, we found that the conditional indirect effects of EF were significant only for spontaneous DM (see Table 5 and Figure 1). Further interpretation of the results indicated that the indirect effects of EF were stronger and negative for middle-aged adults compared to younger ones in the age-spontaneous DM link.

Table 4. Correlations between age, EF, and DM styles for young and middle-aged adults.

Measures	Age	EF	RDM	IDM	DDM	ADM	SDM
Age	1	−.22**	−.12	.04	.19**	.17*	−.16*
EF	−.31**(−.05)	1	.28**	.01	−.27**	−.41*	.22**
RDM	−.29**(−.08)	.39** (.16)	1	.13	−.01	−.34**	.20**
IDM	−.04(.02)	−.14(.19*)	.12(.15)	1	.10	.15*	−.04
DDM	.40**(.13)	−.39**(−.10)	−.03(.03)	.14 (.06)	1	.30**	−.04
ADM	.41**(.02)	−.53**(−.22*)	−.54**(−.15)	.14 (.14)	.34** (.26*)	1	−.40**
SDM	−.30**(.04)	.44**(−.12)	.48**(.07)	−.13(.06)	−.09 (.03)	−.67**(.07)	1

* = p < .05. ** = p < .01; Correlations above the diagonal are for full sample and below the diagonal are for Middle-Aged adults (outside parentheses) and Young adults (within parentheses); EF = Executive Functioning; RDM = Rational Decision-making; DDM = Dependent Decision-making; ADM = Avoidant Decision-making; SDM = Spontaneous Decision-making; IDM = Intuitive Decision-making.

Table 5. Mediation and moderated mediation models showing the mediating role of EF related to age and DM styles across young and middle-aged adults (N = 195).

	Outcome Variables					
	Dependent DM		Avoidant DM		Spontaneous DM	
Predictors	Model 4	Model14	Model 4	Model14	Model 4	Model14
Age	.07*	.17**	.05	.11	−.05	−.04
EF	−.15**	.05	−.28***	−.01	.12*	−.39**
Adulthood stage[a]	-	−2.12	-	−1.40	-	−.16
EFxAdulthoodstage	-	−.12	-	−.17	-	.31***
R2	.09	.12	.18	.20	.06	.13
Model fit	9.40***	6.62***	20.46***	11.51***	6.30**	6.88***
Total effect	.10		.10		−.07	
Direct effect	.07		.05		−.05	
Indirect effect	.03		.05		−.02	
Sobel z test	2.24*		2.77**		−2.04*	
Conditional Indirect effects of EF for Young and Middle-aged Adults	Young = .01 Middle = .03		Young = .03 Middle = .06		Young = .01 Middle = −.04	

* = *p*< .05, ** = *p*< .01; *** = *p*< .001: EF = Executive Functioning; [a] = adulthood stage is taken as a moderator with two levels (Young and Middle-Aged Adults); Values shown are regression weights; df in predicting all three dimensions of DM Styles in M4 = 2, 192 & in M14 = 4,190; Number of bootstrap samples for bias-corrected confidence interval was 5000; In Model 4, when EF was predicted from age, it resulted in a significant regression weight (−.18, p < .01, df = 1,193) accounting for 5% of the variance.

Discussion

The objectives of the current study were two-fold: to assess the mediational link between age, EF, and DM styles, and to assess the conditional indirect relations between age, EF, and five different DM styles across young and middle-aged adults. To achieve these goals, correlations and mediation analyses were initially conducted between age, EF, and DM styles. This was followed by moderated mediation models to assess the conditional indirect relations of EF in the age-DM styles link across the two adulthood groups. From the correlation analyses, we found that EF was significantly correlated with four DM styles: positively correlated with rational and spontaneous DM, and negatively correlated with dependent and avoidant DM. These results suggest that adults with amature EF adopt more rational and spontaneous decision styles but use less dependent and avoidant styles. Evidence from patient (Manes et al., 2002), experimental (Hinson, Jameson, & Whitney, 2003), brain imaging (De Martino, Kumaran, Seymour, & Dolan, 2006), and correlational studies using normal adolescent samples (Crone & van der Molen, 2004; Hooper, Luciana,

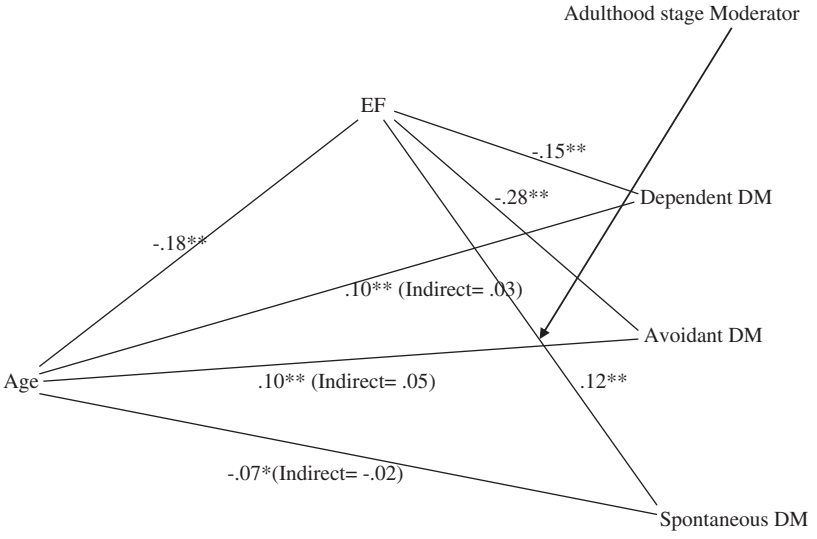

Figure 1. Moderated mediation model assessing indirect relations between age, EF, and decision-making styles as well as conditional indirect effects across adulthood stages (Note: * = $p < .05$, ** = $p < .01$; Values shown are regression weights).

Sobel z (Age-EF-Dependent DM) = 2.24*Sobel z (Age-EF-Avoidant DM) = 2.77**Sobel z (Age-EF-Spontaneous DM) = −2.04*EFxAdulthoodstage = .31** (indirect effects: young = .01, middle = −.04).

Conklin, & Yarger, 2004) has proposed a close association of EF and DM. However, relatively little is known as to how EF is differentially associated with diverse DM styles, particularly among fully functioning adults. The current study thus extends the previous knowledge on the EF-DM link by providing evidence of differential associations with various DM styles.

The positive association between EF and the rational DM style was expected, considering that reasoning represents a fundamental EF skill (Alvarez & Emory, 2006; Ardila, 2018). It is evident that rational DM has the strongest relationship with EF, considering that rational problem solving represents a basic EF element. By the same token, it is understandable that dependent and avoidant DM styles had a negative association with EF, considering that these DM styles are characterized by the reluctance to deal directly and rationally with conditions requiring a personal decision (Stuss & Knight, 2013).

In line with the mediation hypothesis, we found that age was a significant correlate of three DM styles: negatively correlated with spontaneous DM, and positively correlated with dependent and avoidant DM styles. Additionally, EF mediated the three significant associations of age with dependent, avoidant, and spontaneous DM. It seems that DM skills may weaken with increasing age due to the decline in EF abilities. Weak DM styles, such as dependent and avoidant, may become more pronounced, whereas spontaneous DM may be reduced with increasing age due to the weakening of EF skills. Earlier studies on DM have not analyzed spontaneous, avoidant, and dependent styles in relation to age or EF, therefore, direct empirical support for the finding is not available.

For our second objective using moderated mediation analyses, we found that the conditional indirect effects of EF between age and DM styles were significant only for spontaneous DM. This indicates that EF more strongly explained the negative link

between age and spontaneous DM for middle-aged adults compared to younger ones. Several explanations may justify this finding. First, there were differential correlations of age with EF between middle-aged ($r = -.29$, $p < .01$) and younger adults ($r = -.03$, $p > .05$), which possibly revealed age-related differences in mediated relations between the age groups. Although the decline in cognitive skills may start after the mid-20s, as proposed by Park et al. (2002), it is possible that this decline becomes more apparent after 45, which may lead middle-aged adults to use the spontaneous DM style less frequently.

Current findings are noteworthy in that age was not correlated with EF or DM styles in young adults. This finding indicates that the trajectory of EF in young adulthood remains stable, compared to a decline in EF during middle adulthood. These results are in line with previous research in the same cultural context (Fatima, Jamil, & Ardila, 2018). Also, nonsignificant associations of age with DM styles in young adults suggest that preferences for different DM styles during young adulthood are not age dependent. It may be the case that young adults are going through new experiences and are in the process of building strategies for better DM, and this is achieved by adopting all decision styles across different occasions without having an increased or decreased preference for any particular style.

Limitations, strengths, and future directions

Although this is one of the first studies to examine age-related differences in EF and DM styles between young and middle-aged adults, our conclusions are based on a cross-sectional comparison of subjects in two age groups. In a longitudinal study, observing the transformation of EF abilities and DM styles in the same cohorts as they age would provide more authentic information about the meditational role of EF in the age-DM link. Cohort differences may have overestimated aging effects (Hedden & Gabrieli, 2004) because participants from different age cohorts may not perform equally on cognitive or neuropsychological assessments irrespective of their cognitive aptitude simply because of different life experiences and learned skills (Williams & Klug, 1996). Additionally, due to the common methodological challenge of selection bias (i.e., we selected fully functioning, highly educated, and employed young and middle-aged adults), the findings are limited in their scope and cannot be generalized to uneducated and unemployed individuals.

To the best of our knowledge, this is the first study to comparatively assess the conditional indirect effects of EF in the age-DM link among fully functioning normative samples of younger versus middle-aged adults from a South Asian country with a focus on different DM styles. These findings are important in light of findings that suggest that EF skills remain relatively stable during young adulthood (Fatima et al., 2018) but significantly weaken in middle adulthood.

Further research is recommended to assess other factors that may moderate the mediational relations between the age-EF-DM link, such as decision or task context, positive versus negative outcome-based decisions, expertise, positivity effect, among others, given that these may differentially affect DM among younger versus middle-aged adults. Also, future studies should compare adolescents and younger, middle, and older adults to assess how DM skills change as a function of EF development as individuals age. Finally, cross-cultural comparison of DM as a function of EF development is also a potential avenue for future studies.

Conclusion

Taken together, this study shows that: (i) EF abilities mediate the age-DM link for dependent, avoidant, and spontaneous DM; (ii) EF skills strongly mediate the age-DM link for spontaneous DM in middle-aged compared to younger adults; and (iii) EF skills remain stable during early adulthood but weaken prominently during middle adulthood. In short, the study makes a valuable addition in understanding how age-related changes in EF may relate to DM and echoes the finding that EF underpinnings are important factors to consider when assessing DM styles as a function of age, particularly across adulthood.

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