Summary
Age Related Changes
in Metacognitive Processes

Metehan Irak
Bahçeşehir University

Dicle Çapan
Bahçeşehir University

Can Soylu
Bahçeşehir University

Cognition can be defined as a process that is created by the associations between many mental structures, processes, and functions (Liberman, 1994). According to Crick (2000), whereas this meta-mechanism is composed of various elements, it has distinctive characteristics from the properties of its constituent elements. Metacognition, on the other hand, can be defined as metacognitive processes and structures that control and regulate cognitions. It provides individuals the ability to be aware of the processes and functions in their own mind (Crick, 2000; Dienes & Perner, 1999).

Individuals have a number of positive and negative beliefs (meta-cognitions) about the thoughts (non-functional cognitions) affecting their assessments of events (Cartwright-Hatton & Wells 1997; Gwilliam, Wells, & Cartwright-Hatton, 2004). Previous studies about the relationships between metacognition and aging have demonstrated that aging causes a reduction or a slowdown in some cognitive processes such as short-term memory, working memory, visual-spatial perception, and reaction time (Gunstad et al., 2006). For instance, in general, middle and older adults showed lower performance regarding attitudes toward their memory performances and control over their memories compared to younger adults (Hertzog & Hultsch, 2000; Irak, 2008; 2012; Miller & Lachman, 1999).

Ddevelopment of metacognitive processes is generally discussed along with the theory-of-mind (ToM). According to Flavell (1979; 1987) development of ToM begins between ages of 3 to 5 in children and starting from this age,development of metamemory and metacognitive process commences and continues throughout life. In contrast, other metacognitive processes such as monitoring and control begin to develop later in childhood. Development of metacognitive processes continue to develop parallel to the development of other cognitive processes throughout the school years (Alexander, Johnson, Albano, Freygang, & Scott, 2006; Karakelle &

Saraç, 2007; Veenman, Van Hout-Wolters&Afflerbach, 2006).

Many studies have demonstrated that individuals do not have realistic assessments or perceptions to the reliability of their own cognitive processes (such as memory) (Ihlebæk, Love, Eilertsen, & Magnussen, 2003). Thus, it has not been elucidated yet that whether this situation arises from individuals' true sense of lack in their cognitive assessments or from changing metacognitive beliefs as a result of aging. Based on the above-mentioned claims, in this study, it was aimed to investigate the functions of metacognitive processes and age-related changes (either positive or negative) in these processes. Also the effects of level of education and gender on development of metacognition processes were tested.

Method

Participants

One thousand eight hundred and sixteen people aged between 8 to 74 (*M* = 24.58, *SD* = 11.57) participated in this study. Sixty three percent of the participants were female (*n* = 1139) and 37% of the participants were male (*n* = 670). 7 participants did not mention their sex and education level. Thus, the distribution of the participants' level of education was as follows: primary education (8 years) 21.5%, 9-12 years 12.8%, university 45.7% and graduate 21.1%.

Measures

In addition to the socio-demographic information form that was used to determine participants' age, sex, and education level, two scales were used in this study in order to assess metacognitive processes.

Metacognitions Questionnaire-30 Form (MCQ-30). The 30-item short form of the original "Meta-cognitions Questionnaire" was developed by Cartwright-Hatton and Wells (2004). Reliability and validity of the

Address for Correspondence: Metehan Irak, Bahcesehir University Brain & Cognition Research Laboratory, Çırağan Cad. No.4 Beşiktaş Istanbul, Turkey 34353
E-mail: metahan.irak@eas.bahcesehir.edu.tr

Turkish form of MCQ-30 was done by Tosun and Irak (2008) and the scale was found to have adequate psychometric properties. Accordingly, Chronbach's alpha coefficient was found .86. Test-retest analysis results revealed significant correlations between all items and subscales; between .40 and .94 and .70 to .85, respectively. Appropriate with the original form, the Turkish form of MCQ-30 is composed of five factors, which are positive beliefs, uncontrollability and danger, cognitive self-consciousness; need to control thoughts, and cognitive confidence.

Each item in the MCQ-30 is responded on a four-point Likert-type scale that ranges from "(1) strongly disagree" to "(4) strongly agree". Points that could be taken from the scale vary from 30 to 120 and the high score indicates a higher negative metacognitive beliefs and activities.

Child and Adolescent Form of Metacognitive Questionnaire (MCQ-CA). The scale was developed by Bacowki, Pincus, Ehrenreich, and Brody (2009). The adolescent form of MCQ-30 has same structure and number of factors (positive beliefs, uncontrollability and danger, cognitive confidence, self-consciousness, and need to control thoughts) as the adult form. However, during the development of child form of MCQ, the cognitive confidence subscale was excluded from the scale and the final form of Child MCQ consisted of 24 items and four factors.

Standardization of Turkish form of the MCQ-CA was done by Irak (2012). Confirmatory factor analysis results revealed that Turkish form of the MCQ-CA has the same factor structure as the original form. Test-retest correlation coefficients were found between .47 and .88 for the items and between .76 to .82 for the subscales. These results revealed that Turkish form of the MCQ-CA has the adequate psychometric properties.

Each item in the MCQ-CA is responded on a four-point Likert-type scale that ranges from "(1) strongly disagree" to "(4) strongly agree". Points that could be taken from the scale vary from 24 to 96 and high score indicates a higher negative metacognitive beliefs and activities.

Procedure

Data from the participants aged 8 to 17 years was collected visiting 71 primary and secondary public schools with the permission of relevant departments and instructors. Data from the participants aged 18 to 25, on the other hand, was collected from the private and public universities in Ankara, Istanbul, Bursa, and Izmir. Older participants were assessed using snowball sampling again in the same cities at either their homes or workplaces. Participation of the study was voluntary basis. Administrations were conducted in a single session that took approximately 8-12 minutes for each subject. Study was conducted between May 2011 to September 2013.

Results

Prior to analyses, data were screened for missing values, as well as univariate and multivariate outliers (Tabachnick & Fidell, 2007). There were no outliers identified as multivariate using Mahalanobis distance with $p < .001$, nor univariate using z-scores ($\left| z \right| \geq 3.30$).

A 5 (age: 8-12 years, 13-17 years, 18-29 years, 30-44 years, and 45+) x 4 (level of education: primary
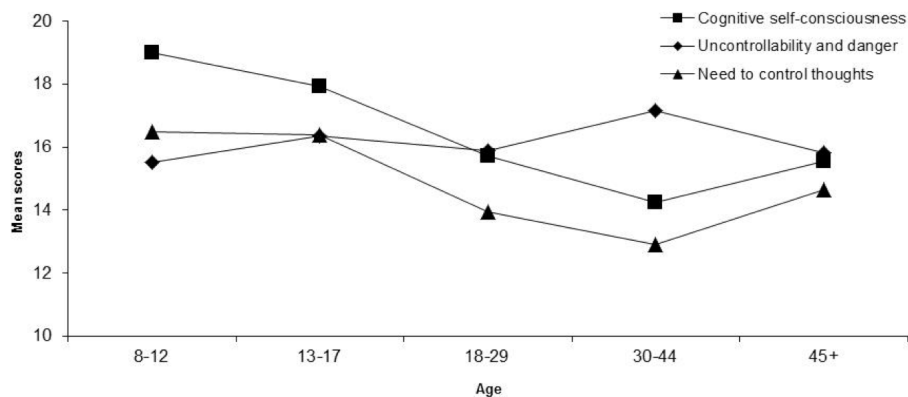

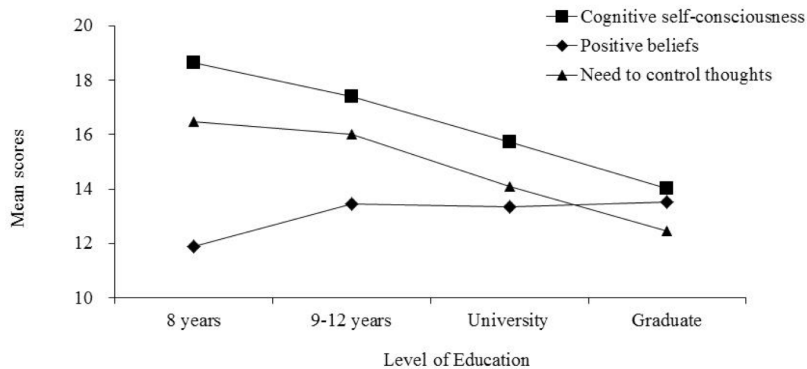**Figure 1.** Relationships between Age and MCQ-30 Sub-Factors

Figure 2. Relationships between Level of Education and MCQ-30 Sub-Factors

school, high school, university, and graduate) x 2 (sex: male and female) MANOVA for factorial design was conducted. According to the results, the main effect of age (Wilks' Lambda = 5.67, $p < .001$, $\eta^2 = .013$) on the cognitive awareness ($F_{4,1683} = 12.45$, $p < .001$, $\eta^2 = .029$), uncontrollability and danger ($F_{4,1683} = 3.61$, $p < .01$, $\eta^2 = .009$), and the need to control thoughts ($F_{4,1683} = 3.44$, $p < .01$, $\eta^2 = .008$) subscales were found significant. Results showed that scores obtained from the subscales positively increased with age.

Level of education main effect (Wilks' Lambda = 5.48, $p < .001$, $\eta^2 = .013$) was found significant on the subscales of need to control thoughts ($F_{3,1683} = 10.08$, $p < .001$, $\eta^2 = .018$), positive beliefs ($F_{3,1683} = 3.84$, $p < .01$,

$\eta^2 = .007$), and the cognitive self-consciousness ($F_{3,1683} = 7.51$, $p < .001$, $\eta^2 = .013$). Results revealed that with the increasing level of education, a significant decrease occurred in the cognitive self-consciousness and need to control thoughts scores. However, a small increase in the positive beliefs subscale scores after 8 years of education did not continue to increase parallel with the increase of level of education.

In addition to the above-mentioned results, the interaction effect of age and level of education (Wilks' Lambda = 2.97, $p < .001$, $\eta^2 = .01$) were found significant on the cognitive self-consciousness ($F_{6,1683} = 5.24$, $p < .001$, $\eta^2 = .018$) and the uncontrollability and danger ($F_{6,1422} = 3.9$, $p < .01$, $\eta^2 = .014$) subscales.
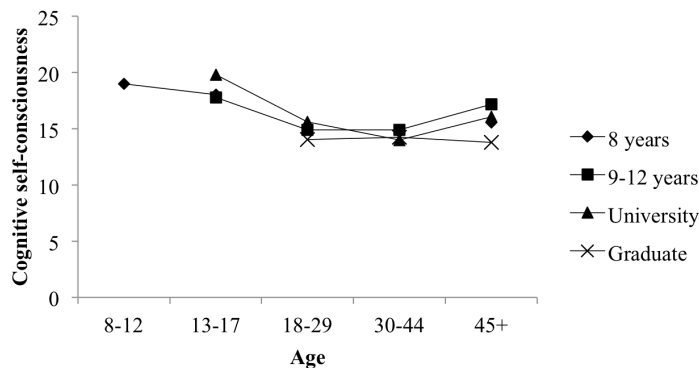

Figure 3. Interaction Effect of Age and Level of Education on Cognitive Self-Consciousness Sub-Factor
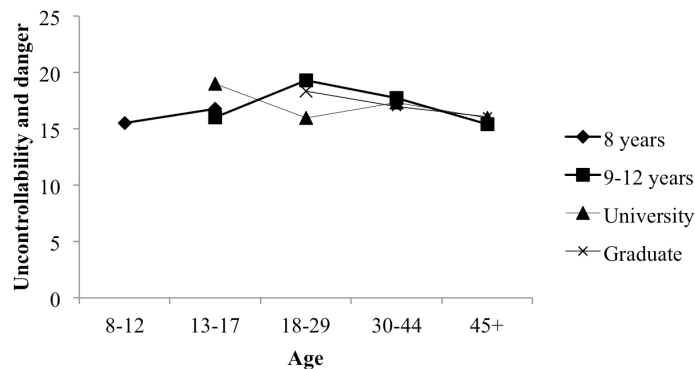
Figure 4. Interaction Effect of Age and Level of Education on Uncontrollability and Danger Sub-Factor

Regression analysis has revealed similar results. These results suggested that such metacognitive processes, especially, the cognitive self-consciousness, uncontrollability and danger, and the need to control thoughts were affected by the age and level of education ($R^2 \geq$ .090). Thus, with the increasing age and level of education a decrease was seen in the metacognitive beliefs in general. Lastly, gender main effect was not significant on any MCQ-30 and MCQ-CA subscales.

Discussion

In the standardization study of MCQ-30 on Turkish sample (Tosun & Irak, 2008), the main effect of age on the cognitive self-consciousness, uncontrollability and danger, and the need to control thoughts subscales was found significant. This result was relevant with the previous findings which suggest a decrease in the negative metacognitive processes with aging. Cognitive self-consciousness sub factor measures to what extent individuals focus on their own metacognitive processes. The relationships between cognitive self-consciousness and age and level of education can be explained by the increase of confidence against one's own cognitive awareness as a result of increasing age and level of education.

Uncontrollability and danger sub factors are associated with the metacognitive processes that provide individuals to control their concerns against mental and physical dangers in order to sustain their functionality (Cartwright-Hatton & Wells, 1997; Tosun & Irak, 2008). Results of the present study suggested that with aging and increasing level of education, a positive change occur in the negative metacognitive beliefs.

The need to control thoughts is associated with the metacognitive processes, which provide individuals with the thoughts that they should control some of their thoughts; otherwise they might cause negative outcomes. Similarly these kinds of negative metacognitive processes were found to decrease with aging and increasing level of education (Cartwright-Hatton & Wells, 1997; Tosun & Irak, 2008).

Previous studies indicated that actual memory performance is thought to be a significant predictor of memory confidence. Also, it was found that there were positive correlations between amount of information that could be reached in memory and individuals' confidence against their memory and their metacognitive performance (Blake, 1973; Koriat, 1993; 2007; Nelson, 1984; Nelson & Narens, 1990). Irak's (2012) study on Turkish sample showed that majority of the participants have stated that their metacognitive evaluations are neither good nor bad. Participants who have given poor evaluations about their metacognitive processes were generally consisted of individuals from 18 to 29 years of age. Author concluded that individuals after the age of 30, in general, have positive beliefs about their metacognitive processes.

This positive change in the metacognitive processes can be explained with the characteristics of the relevant age period. The decrease in the negative metacognitive processes covers an age period that includes early adulthood (20 to 40 years). According to the stage theory, this period reveal a unique developmental profile. In this period, reflective and relativistic thinking is alleged to arise. Sinnot (2003) stated that the development of individuals' thought processes is a part of the overall development.

Another variable that could be used to explain the relationships between age, level of education, and meta-cognitive processes is the anxiety levels of individuals. The relationships between trait-anxiety and metacognitive processes have long been revealed in the literature (e.g., Wells, 2005; Cartwright-Hatton et al., 2004). Especially both original studies on MCQ-CA and MCQ-30 (Bacow, Pincus, Ehrenreich, & Brody, 2009; Wells & Cartwright-Hatton, 2004) and also standardization studies in Turkish culture (Irak, 2012a; Tosun & Irak, 2008)

indicated that same sub factors were reported to be in positive relations with trait anxiety scores.

The present study has some limitations. Although the sample size is quite adequate, participants have not been evenly distributed between age groups and levels of education. Another point is the small number of elderly participants. Further studies should investigate the relationships between healthy aging, and prospective metacognitive processes, actual memory performance, individuals' anxiety levels, and personality traits.