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'HALT HYPOTHESIS' IN METACOGNITIVE DEVELOPMENT: EVIDENCE FROM COLLEGE STUDENTS

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Abstract

Gender difference in metacognition has been a controversial issue. Prior researches have shown inconsistent results regarding the differences in metacognitive skills of boys and girls. At the same time some researchers have also observed that until the age of 14, children's metacognitive skills have a substantial domain orientation and beyond the age of 14, metacognitive skills merge into a generalized repertoire across the domains following a period halt in the development, which they proposed as the 'halt hypothesis'. The present research addresses both these issues of metacognitive development. Six hundred boys and girls reading in higher secondary to degree classes in age group of 15 to 20 years participated in the study. The Metacognitive Awareness Inventories were administered on them to measure their skills in metacognitive knowledge, regulation and executive control. Firstly, the results supported gender difference in the development of metacognitive skill but could not subscribe to any univocal nature of difference. It pointed out that girls are better in metacognitive knowledge while boys are better in metacognitive regulation and they are same in executive control. The results also strongly supported the halt hypothesis but with differences that the halt period may be longer and beyond 15 years of age and also varies with respect to different metacognitive skills.

***Keywords**: halt hypothesis, metacognitive knowledge, regulation, control and execution*

Introduction

Although the development of metacognitive skills is assumed to commence at the age of 8 to 9 years (Veenman, 2011), children younger than 8 years are not entirely devoid of metacognitive skills if the task is tailored to their interest and level of understanding. Even 5-year-old children may demonstrate elementary forms of planning and self-correction in playful situations, such as distributing dolls over a limited number of chairs (Whitebread et al., 2009). Apparently, metacognitive skills start to develop at a basic level during early childhood years, but they become more sophisticated and academically oriented when formal education requires the utilization of a metacognitive repertoire (Veenman, 2011). From the age of 8 years on, children show a steep increase in frequency and quality of metacognitive

skills (e.g., Alexander, Carr, &Schwanenflugel, 1995; Schmitt &Sha, 2009; Van der Stel&Veenman, 2010; Veenman and Spaans (2015); Veenman, Wilhelm, &Beishuizen, 2004). This growth of metacognitive skills persists well into adulthood (Veenman et al., 2004; Weil et al., 2013). At all ages, however, huge individual differences in metacognitive skills can be observed in same-age learners, indicating a differential developmental pace of metacognitive skills not only in quantity but also in quality (Van der Stel&Veenman, 2014; Veenman et al., 2004). The findings of above research clearly pointed to qualitative changes in the metacognitive development of students. The present research is concerned to address the nature of the qualitative changes during adolescents.

In fact, the concept of the present research was derived from the findings of the study entitled "Developmental differences in metacognitive skills: Gender by Age interaction" (Hesselink, Sleeuwaegen, Liem&Haaren, 2012). The longitudinal study reported that until the age of 14, children's metacognitive skills have a substantial domain or task specific orientation and beyond the age of 14, metacognitive skills merge into a generalized repertoire across tasks and domains. In another longitudinal study, Van der Stel and Veenman (2014) followed 13 year olds for three successive years as they performed reading task in history and problem-solving task in mathematics each year. Between the ages of 13 to 14 years, children's metacognitive skills for both tasks improved, but growth leveled off between 14 to 15 years. At the same time, metacognitive skills shifted from being partly task or domain-specific to becoming entirely general by the age of 15 years. Principal-component analysis on metacognitive skill measures for both tasks extracted a general component along with a weaker domain specific component in the first two years. But at the age of 15 years, however, only a strong general component remained.

On the basis of a further study, Veenman and Spaans (2015) argued that around the age of 11 to 14, metacognitive skills develop on separate islands of tasks and domains which are synthesized into a generalized complex metacognitive skill relevant to different types of tasks and domains during the age between 15 and 20 years. Van der Stel and Spaansalso postulated that this qualitative change into a generalized repertoire of metacognitive skills goes at the expense of a temporary halt in metacognitive growth during 13 to 14 years, which they referred to as 'Halt hypothesis' in metacognitive development. Several prior studies have also reported that beyond the age of 15, learners resume metacognitive growth and have a personal repertoire of metacognitive skills at their disposal that they tend to apply to any

new task. (Schraw, Dunkle, Bendixen, &Roedel, 1995; Schraw&Nietfeld, 1998; Veenman&Beishuizen, 2004; Veenman, Elshout, & Meijer, 1997; Veenman and Spaans (2015); Veenman&Verheij, 2003; Veenman et al., 2004). Van der Stel and Veenman (2014), however, could not establish such resumed growth in general metacognitive skills, as their study did not include measurements beyond the age of 15. Therefore, the present research is thought of providing continuity to Van der Stel and Veeman to find support for a continuation of growth into a generalized repertoire between 15 to 20 years of age and also the nature of halt or stagnation in respect of different metacognitive skills. In view of these objectives, the present research focused on adolescents in five age groups from 14 to 20 years of age and analyses the nature of development in different metacognitive skills such as metacognitive knowledge, metacognition and metacognitive executive control during this period.

Gender difference in metacognition

Gender difference in metacognition has been a controversial issue. Prior research has shown inconsistent results regarding the differences in metacognitive skills of boys and girls. Some research suggests that there are differences regarding boys' and girls' metacognitive skills, while others suggest that these differences are not significant. Pajeres and Valiante (2002), in their study on academic achievement among adolescents found girls showed more confidence in ability to self-regulate their learning tasks which reflect on their higher metacognitive ability. Peklaj and Peejak (2002) found that girls were more aware about the role of thinking in self-regulation of learning. They used more metacognitive strategies and were motivated than boys to express feelings related to learning. Similarly, Zimmerman and Martinez (2010) interviewed the students of eleventh grades to study gender differences in use of self-regulated learning strategies. Girls displayed more goal setting, planning strategies and self-monitoring than boys and also surpassed them in their ability to structure their environment for optimal learning. Further, Pokay and Blumenfeld (2012) found that girls used more cognitive and metacognitive strategies and also displayed better strategy management. On the other hand, research indicate that the self-perception of academic ability, particularly in mathematics and science tend to be lower in the case of girls, and this tendency appears to reach its highest during adolescence (Virtanen &Nevgi, 2010). Nonetheless, Zimermann and Martinez (2010)), and recently Zhu (2007) reported that there are no significant differences between boys and girls regarding mathematics selfefficacy.

Niemivirta (1997) reported that compared to girls, boys are more natural in the use of their metacognitive skills, while girls are more effortful. Arising from these findings of research it would be definitely interesting to examine gender differences in respect of the 'halt hypothesis' and present research has also included this objective into it.

Objectives

1. To study the nature of development in each of the metacognitive skills namely; metacognitive knowledge, metacognitive regulation, and metacognitive executive control in both boys and girls from 15 to 20 years of age.

2. To find out if there are periods of halt or stagnation in respect of each of the metacognitive skills and whether the 'halt' period varies for boys and girls.

Method

Participants were 600 students from higher secondary to graduate classes, including equal number of boys and girlsfrom each of the 15-16, 16-17, 17-18, 18-19 and 19-20 years of age. Sixty subjects were included in each of the ten groups. All the subjects completed the Metacognitive Awareness Inventory (MAI-Schraw& Dennison, 1994) and Metacognitive Executive Control Inventory (MECI). These two are widely used measures of metacognitive skills with sound psychometric properties established by previous researchers (e.g., Harrison &Vallin, 2017). The MAI consisted of 52 items in statements to be responded by the subject on a five-point scale (0-4) ranging between completely false to completely true about him / her. It measures two constructs namely metacognitive knowledge, and metacognitive regulation. Metacognitive knowledge includes declarative knowledge (8 items); procedural knowledge (4 items) and conditional knowledge (5 items). Metacognitive regulation includes planning (7 items), information management (10 items),comprehension monitoring (7 items), debugging strategies (5 items) and evaluation (6 items).Further 18 items were added to measure Executive control of cognition which includes self-regulation (6 items), proactive control (6 items), and metacognitive decision (6 items). Hence the total items for metacognitive knowledge is 17 resulting in a maximum score of 68, for metacognitive regulation is 35, resulting in a maximum score of 140and for executive control 18, resulting in a maximum score of 72. However, because of wide variations in the maximum scores of the three metacognitive measures, the data followed a standard conversion of 'out of 30' for each of the three measures. Thirty was chosen as a small number to be easy for statistical

analyses. In the first place, each subject's score on each of the measures was converted to as out of 30 and then statistical analyses were carried out.

Results

Metacognitive Knowledge: The means and standard deviations ofmetacognitive knowledge for both boys and girls are reported in Table 1. As there were appreciable changes in the means, two-way analysis of variance were computed to test effects of both gender and age on the development of metacognitive knowledge. Further, Tukey's HSD were calculated to examine the nature of changes across the age groups. The results are also reported in Table 1. It is observed in the results that main effects of both gender and age are significant. Looking at the trend of the means (Figure 1) it is found that compared to boys, girls are better in metacognitive knowledge. Now, coming to the multiple comparisons, it is observed that boys and girls don't have significant differences in the metacognitive knowledge from 15 to 17 years of age and then from 17 to 20 years, girls grow up better in metacognitive knowledge than boys. Further, it is also observed that neither boys nor girls change in their metacognitive knowledge from 15 to 17 years of age which may be considered as the period of stagnation or halt in the development of metacognitive knowledge. On the other hand, both boys and girls were found to improve consistently in metacognitive knowledge from 17 to 20 years of age. This result is definitely supportive to 'Halt hypothesis' that after a period of halt, there is a steep rise in the metacognitive knowledge due to the developed of more generalized repertoire.

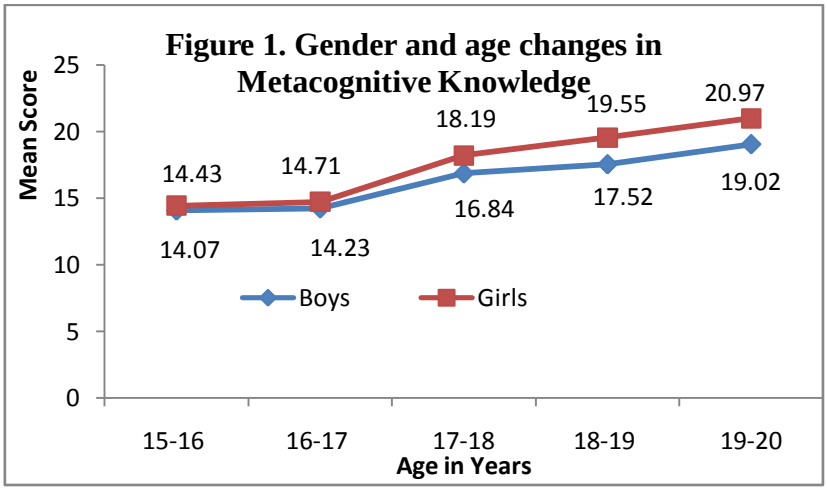
Table 1 Summary of Analysis of Variance showing the Gender and Age related changes in Metacognitive Knowledge

Sources	**SS**	**df**	**Ms**	**F**
Gender (A)	172.39	1	172.39	23.36**
Age (B)	367.23	4	91.89	12.44**
A x B	278.67	4	69.67	9.54**
Within	4351.76	590	7.38	

Age in Years		15-16	16-17	17-18	18-19	19-20
Boys	Mean	14.07	14.23	16.84	17.52	19.02
	SD	1.93	2.36	2.68	2.71	2.56
Girls	Mean	14.43	14.71	18.19	19.55	20.97
	SD	2.27	2.43	2.81	2.32	2.85

Comparison of selected group differences by Tukey's HSD				
B_1G_1	B_2G_2	B_3G_3**	B_4G_4**	B_5G_5**
B_1B_2	B_2B_3**	B_3B_4**	B_4B_5**	B_5B_1**
G_1G_2	G_2G_3**	G_3G_4**	G_4G_5**	G_5G_1**

Note: B_1, B_2, B_3, B_4 and B_5 respectively denote boys of 15-16, 16-17, 17-18, 18-19, and 19-20 years old and G1, G2, G3, G4, and G5 respectively denote the girls of the same age groups. These notations will also be subsequently used for other conditions of post hoc tests.

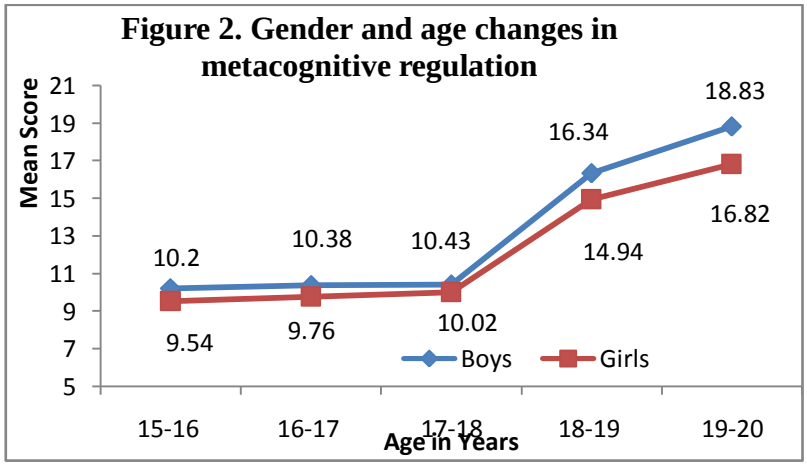


Metacognitive regulation: Likewise, the means and standard deviation of metacognitive regulation for both boys and girls are reported in Table 2. Observed changes in the means also implied for calculating two-way analysis on the data and also Tukey's HSD test for multiple comparison of means. The results also showed that both the main effects of gender and age are significant. However, this time it is found from the results that, boys are superior to girls in metacognitive regulation (Figure 2). But in the results of HSD, it is observed that boys and girls don't differ significantly in metacognitive regulation up to 18 years of age while after this age, boys grow up quicker than girls. Further, in respect of development of metacognitive regulation across the age groups, it is observed in the results of Tukey's HSD that there is no significant development in metacognitive regulation for both boys and girls from 15 to 18 years of age while from 18 to 20 years; both boys and girls significantly improved in their abilities of metacognitive regulation. Such a finding clearly pointed to proving the 'Halt hypothesis. But in metacognitive regulation, the halt period is longer than that of metacognitive knowledge.

Table 2 Summary of Analysis of Variance showing the Gender and Age related changes in Metacognitive Regulation

Sources		**SS**	**df**	**Ms**	**F**	
Gender (A)		163.37	1	163.37	18.65**	
Age (B)		859.88	4	214.97	24.54**	
A x B		166.79	4	41.70	4.76**	
Within		5167.32	590	8.76		
Age in Years		15-16	16-17	17-18	18-19	19-20
Boys	Mean	10.20	10.38	10.43	16.34	18.83
	SD	2.09	2.16	2.47	2.93	2.25
Girls	Mean	9.54	9.76	10.02	14.94	16.82
	SD	2.42	2.31	2.29	2.66	2.58
Comparison of selected group differences by Tukey's HSD						
B_1G_1	B_2G_2	B_3G_3	B_4G_4**	B_5G_5**		
B_1B_2	B_2B_3	B_3B_4**	B_4B_5**	B_5B_1**		
G_1G_2	G_2G_3	G_3G_4**	G_4G_5**	G_5G_1**		

Note: Same as Table 2

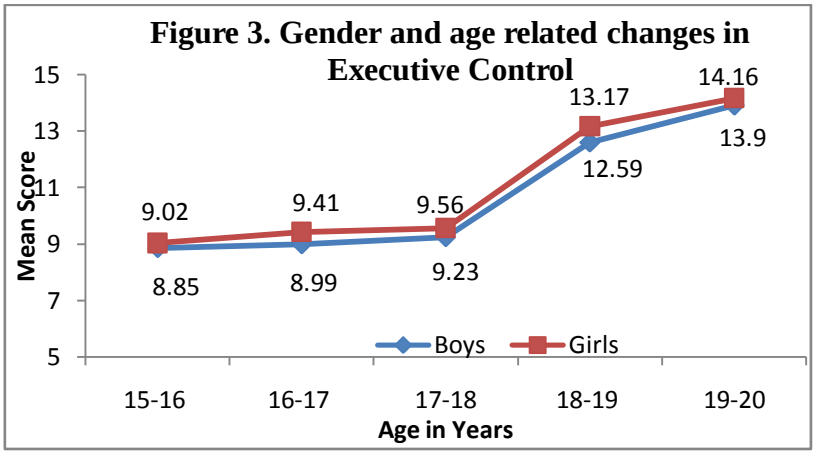


Metacognitive executive control: The means and standard deviations for the metacognitive executive control are reported in Table 3. The means across the age groups also showed variations and therefore, two-way ANOVA with Tukey's HSD were computed and results are reported in Table 3. However, it is found in the result that that the main effect of age is only significant. Hence, it may be pointed out that while girls are better in metacognitive knowledge, boys are better in metacognitive regulation, they are equal in executive control. On the other hand, looking at the development of metacognitive control across age groups, it is found that neither boys nor girls improve in metacognitive executive control between 15 to 18 years of age while both boys and girls grow up substantially between 18 to 20 years of age. This result also supported the 'halt hypothesis', but the halt period is also found to be longer than that of metacognitive knowledge and similar to that of metacognitive regulation.

Table 3 Summary of Analysis of Variance showing the Gender and Age related changes in Executive Control

Sources		**SS**	**df**	**Ms**	**F**	
Gender (A)		20.61	1	20.61	2.46	
Age (B)		413.76	4	103.44	22.39**	
A x B		53.03	4	13.26	2.87	
Within		2726.34	590	4.62		
Age in Years		15-16	16-17	17-18	18-19	19-20
Boys	Mean	8.85	8.99	9.23	12.59	13.90
	SD	1.77	1.35	1.69	1.52	2.37
Girls	Mean	9.02	9.41	9.56	13.17	14.16
	SD	1.21	1.67	1.54	1.61	1.95
Comparison of selected group differences by Tukey's HSD						
B_1B_2		B_2B_3	B_3B_4**	B_4B_5**	B_5B_1**	
G_1G_2		G_2G_3	G_3G_4**	G_4G_5**	G_5G_1**	

Note:*same as Table 2*



Conclusion

Arising from the results of the present research, following conclusions may be derived. (i) There is gender difference in the development of metacognitive skills but it is not univocal either in favor of boys or in favor of girls. While girls are better than boys in metacognitive knowledge, boys are better in metacognitive regulation and both are same in metacognitive executive control. This finding throws some light on the controversy of gender difference in metacognitive development by suggesting that there are gender differences in the development of metacognitive skills at the level of the constituent skills but when it comes to overall development, there may not be any gender difference. (ii) The results of the present study also strongly supported the 'halt hypothesis' but with some differences. Prior studies reported that the halt period of metacognitive development is during 14 to 15 years of age, while in the present study, the halt period continued through 15 to 17 years for metacognitive knowledge, and even 15 to 18 years for metacognitive regulation and metacognitive executive control. The results implied two things; there may be variations in the length of halt period depending on the socio-cultural factors and also the halt period is not same for different metacognitive skills. However, in the results of the present study, there is no evidence of gender difference in respect of the halt period. The findings of the present study are appreciable that it highlighted some important issues in metacognitive development and also opened up a new issue with regard to socio-cultural consequences in metacognitive development.

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