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# *Summary*

# The Relationship between Information and The Level of Communication Technology Use, Motivations and Cognitive Abilities

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Information and communication technologies (ICT) have been improving due to the changing and developing nature of technology. The innovations of the ICT are incredible when its history is taken into account. For instance, there are surprising differences between the first phones invented by Graham Bell in 1876 and the new smartphones. The ICT's digital evolution started with the production of smart devices in 70's. In Turkey, it gained accessibility first in 80's and it became common in daily lives.

There are many studies on the relationship between intense technology use and cognitive abilities. However, most of the studies are executed in the developed countries (e.g., Abramson et al., 2009; Anguera & Gazzaley, 2015; Boot et al., 2008; Hoang et al., 2016; Sparrow, Liu & Wegner, 2011). Turkey follows the developing technology closely owing to its young population but there is no study found on this manner in our country.

The current study aims to fill the gap in the literature regarding the relationship between ICT and cognitive abilities. Therefore, this study was designed to examine the relationships between ICT use level, ICT use motivations and short-term memory, working memory, and executive functions.

**Views on cognitive effects of technology use**

**Neuroplasticity view**. Neuroplasticity is characterized by being structural or functional adaptive changes which are caused by internal or external stimuli on neurons or synaptic connections (Uzbay, 2010). For instance, cognitive stimuli triggering neuroplasticity provide increased white matter volume in the brain areas related with the cognitive activity (Jak, 2012). Thus, information processing become faster in those areas (Carlson, 2010; Mather, 2009). Digital technologies, as external stimuli, are supposed to be able to cause structural changes in the brain (Choudhury & McKinney, 2013). Some imaging studies (e.g., Small et al., 2009) showed that digital technology interventions increased white matter in the related areas after the intervention.

**"Use-it-or-Lose-it" phenomenon**. The phenomenon assumes that cognitive experiences can change brain structure negatively or positively via neuroplasticity (Choudhury & McKinney, 2013). According to this view, cognitive abilities which are used frequently promote generation of new neurons and contribute to the strengthening of the existing synaptic connections, and so the performance of the cognitive abilities improve more and can be active longer time ("Use") (Choudhury & McKinney, 2013; Tardif & Simard, 2011). For example, taxi drivers or chess specialists are known that they have more white matter volume in the related brain areas (Maguire et al., 2003). On the other hand, stronger connections which are generated by neuroplasticity are vulnerable to weakening, when they are used rarely ("Lose") (Choudhury & McKinney, 2013; Tardif & Simard, 2011). The plasticity can be seen clearly in animal studies which showed the effects of enriched and impoverished environments on the brain structure (e.g., Jak, 2012; Rosenzweig & Bennett, 1996).

**Short-term memory (STM)**

It is reported that using phones frequently may contribute to the STM improvement (Ng et al., 2012), but texting frequency is not related with the STM performance (Plester et al., 2009). Sparrow and others (2011) showed that participants remember less information, which they obtained from the internet, when they said that they will have the internet connection in the memory test. The results gave researchers the idea that the internet might be used like an external memory by these people. However, the results could not be repeated by Friede (2013).

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**Working memory (WM)**

Since search engines on internet can record the websites visited, resembled WM, it is thought that it can lighten the load of WM (Kubeck, Miller-Albrecht & Murphy, 1999). Sharit and others (2008) showed that internet use provides improvement on WM and they also suggested that internet might provide a WM practice. However, Kubeck and others (1999) found no relationship between them and they assumed that WM is not needed anymore since the search engine behave like a WM.

**Executive functions (EF)**

Tun and Lachman (2010) showed that the more use of computers provides higher performance on EF. An imaging study (Small et al., 2009) reported extra activations in the brain areas having role on decision and reasoning abilities which are the functions of EF. Also, while digital phone use provides improvement on EF performance (Ng et al., 2012), TV viewing causes decreased EF performance (Hoang et al., 2016).

**Sustained attention (SA)**

The studies on SA and ICT which generally focus on computer games yielded mixed results. For instance, Peretz et al. (2011) found that computer games provide better SA performance. On the other hand, Dye and others (2009) found no relationships between playing computer games and sustaining attention performance.

**The hypotheses**

This study tries to understand how technology use motivations and cognitive abilities relate. Therefore the following hypotheses were tested:

1. The level of cell phone/smartphone and computers (desktop, notebook or tablet PC) use and EF, SA, WM would be positively related,
2. There would be a relationship between Internet use level and memory performance (STM and WM),
3. Playing computer games and SA would yield a positive relationship,
4. It was expected that ICT use level and cognitive performances of EF, SA, WM and STM would be positively related.

## Method

**Participants**

One hundred and nineteen undergraduate students of Uludag University participated to the study voluntarily. These students (96 female) were from various departments and aged between 18 and 33 ($M$ = 21, 89, $SD$ = 1.80) .

**Measures**

**Inventory**. The inventory contained three parts. The first part aimed to obtain demographics of the participants. The second part included questions about how long they use ICTs (phone, notebook, desktop PC, Tablet PC and internet) and how many hours they use on daily basis. The third part measured ICT use motivations of the participants (i.e., sending/reading text message, social media, watching TV/Video, using functions of the devices-GPRS, alarm clock, calculation etc.-, researching, communicating, listening to music, playing game).

**Continuous performance test (CPT).** CPT was developed by Rosvold, Mirsky, Sarason, Bransom, and Beck (1956) to measure the sustained attention performance and computerized by Karamürsel (1994) in Turkey (as cited in Zaimoğlu, 1997). Participants were presented with letters presented for 160 ms with the 800 ms Inter-stimulus Interval (ISI). Participants were told to press the spacebar when they see letter "A" followed by the letter "Z". Target stimuli were %20 of the total stimuli. Omissions, number and reaction time of the false response were counted for each participant. While omission errors were used to give information about inattention and false response reaction time provided information about inattention as well as impulsivity (Zaimoğlu, 1997).

**Forward and backward digit spans**. In the study, the digit span tasks adapted from Wechsler Intelligence Scale for Children- Revised (WISC-R) which is standardized by Savaşır and Şahin (1995) in Turkey. The digit spans which measure short term and working memory (Öktem, 2004 as cited in Tekeli, 2013) are limited to 6 forward and to 4 backward span for normal Turkish people (Peker & Karagöz, 2009).

**Verbal fluency.** The task which is used to measure EF performance was composed of two parts: Word and category fluency. In word fluency part, participants were told to generate words from initial letters of K, A or S as much as possible in one minute. Also participants were warned about that special names, digits and verbs should not be included. In the category fluency task, participants were asked to generate as many words as possible from the given categories (cloths, vegetables, furniture, and animal) in one minute.

**Procedure**

In the current study, participants were given written informed consents and they filled the inventory including questions about their demographics, their ICT use level and motivations. Then, participants were tested individually with Continuous Performance Test (CPT) and Forward and Backward Digit Span tasks,

respectively. All participants were informed about the procedures of the tasks and they were provided short practices before the tasks. In the study Open sesame 2.9.5 software (Mathôt, Schreij, & Theeuwes, 2012) was used.

## Results

CPT omission score was found to be related negatively with variable that shows the total years of Tablet PC use ($r_\tau$, $N = 119 = -.18$, $p < .05$), but cell phone/smartphone use did not yield any relationship ($p > .05$). Thus, H1 was rejected. There were seen no relationships between internet use and STM or WM ($p > .05$). Thus, H2 was also rejected. Since there is no significant relationship between playing computer game and SA ($p > .05$), H3 was rejected. The variable ICT use level (the total of each digital device) was not seem to be related with any of the cognitive performances ($p > .05$). However, significant relationships were found between some cognitive performances and TV and Tablet PC use, when the variables were analyzed separately. For instance, tablet use (in years) was related negatively with CPT omission ($r_\tau = -.16$, $p < .05$) score and positively with forward digit span score ($r_\tau = .18$, $p < .05$). Daily watching TV time was related positively with forward ($r_\tau = .21$, $p < .05$) and backward digit spans ($r_\tau = .19$, $p < .05$). Therefore, H4 was accepted partially. There were seen positive relationships between motivation of playing game and forward ($r_\tau = .24$, $p < .01$) backward digit spans ($r_\tau = .15$, $p < .05$).

## Discussion

The current study aimed to examine relationships between the level of ICT use, the use motivations and cognitive abilities. The results of the study showed that STM was related positively with TV and Tablet PC use, WM was related positively with TV use, SA was related negatively with Tablet PC use and related positively with the technology use motivation of playing game, and EF was not related with any measures of technology use level or motivation.

The results showed new relationships and most of the results did not repeat previous results of the literature. It might be due to the short technology history of Turkey. Although Turkey follows the innovations of ICT closely, the extensive use of ICT at home has started in 2000s (TUİK, 2017). Besides, some methodological differences of the present study might explain the different results. Unlike this study, most of the studies in the literature preferred to use Likert type measures of the inventories which obtain information about participants' ICT use and they analyzed their data with extreme-group analysis. However, in this study, problems of Likert type measures (e.g., tendency bias) and comparing extreme-groups were avoided.

There are some limitations of the study. First, the study had a small sample size as compared to the previous studies'. Second, the sample which was composed of students from different departments might cause the data to be lack of normal distribution. Last, since the study was not a longitudinal one and had self-reported measure of ICT, they might weaken the relationships and also causality between ICT and cognitive performances. Therefore, further studies which are longitudinal and experimental, as well as comparing different age groups will enrich the literature, especially in Turkey.