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Feasibility of online divergent thinking assessment

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ABSTRACT

Two studies explored whether assessment of creative thinking is feasible using web-based methods and how participants reacted to the imposition of time constraints in online settings. Sixty-five participants (Study 1) completed a verbal fluency task and a divergent thinking task, half of the participants doing so over the Internet. Online administration did not affect originality, but led to slightly fewer responses overall. This demonstrated that online administration of creative thinking is indeed feasible and reliable, though steps must be taken to ensure participants exhaust all possible responses. To test the effect of time limits on responses, 84 participants (Study 2) completed a verbal fluency task and three divergent thinking tasks online, half of the participants doing so under time pressure (3 min). There were significant interactions between time limits and task content for both time-on-task and fluency variables, but the task type was the dominant force in the varying fluency and time-on-task scores. Originality was not significantly affected by time limits, but did vary across tasks. In all cases the results illustrate that assessment of divergent thinking, as a proxy of creative thinking, is feasible using online methods. Implications for future work in this area are discussed.

1. Divergent thinking, verbal fluency, and time-on-task over the Internet

Creativity is a complex construct often defined in terms of a confluence of factors that lead to novel and appropriate solutions to open-ended problems (Plucker, Beghetto, & Dow, 2004). The complexity of the construct means that fostering creativity is a formidable task for educators (Kim, 2011) and managers (Reiter-Palmon & Illies, 2004) alike. One issue may be attributed to a reliance on lab-based assessments of creative thinking, which do not allow for the tracking of creative thinking throughout every-day life. Thus, we must be able to deliver creativity tasks to participants when they are in a more natural setting. Young people are spending more and more time on the Internet (Calderwood, Ackerman, & Conklin, 2014) and the Internet environment lends itself to data collection via apps and surveys. The two studies in this paper aimed to investigate both the feasibility and effect on behavior of an Internet-based method for assessing creativity via its most common laboratory proxy, divergent thinking.

1.1. An overview of divergent thinking methods

Though not synonymous with the whole of the creativity construct (Runco, 2008), DT has been used extensively as an indicator of creativity potential for the last six decades (see also Albert & Runco, 1999). Guilford (e.g., Wilson, Guilford, & Christensen, 1953) originally conceived of DT (he used the term divergent production) as an intellectual factor crucial for creative problem solving (cf. Guilford, 1967). His reasoning for this was that standardized aptitude and intelligence tests of the time—which, in his view, measured so-called convergent thinking—failed to distinguish between creative and non-creative individuals (Guilford, 1950). Thus, he, in parallel with educational psychologists like Torrance (cf., 1979) began an effort to assess creativity with psychometric instruments.

At least 7 independent DT test batteries now exist, each of which captures a slightly different picture of creativity. Though there are tests of verbal, figural (i.e. drawing), and motor creativity, the verbal tests are quite common in laboratory studies of creativity (Dietrich & Kanso, 2010; Jung, Mead, Carrasco, & Flores, 2013; Silvia et al., 2008). All of the verbal batteries utilize a version of the Alternative Uses Task (AUT, a. k. a. "Unusual Uses", or "Uses"). The task has been adapted for use with adult participants (Wilson et al., 1953) and with children (e.g., Torrance & Michie, 1959; Wallach & Kogan, 1965). In modern variants of the AUT, participants are asked to think of as many uses as possible for a common object such as a brick. Participants' performance is assessed in terms of the *fluency* (total number of responses per prompt) and *originality*. The fluency criterion is a nod to verbal fluency tasks (e.g., name as many words that begin with "F"), while definitions of originality are the subject of considerable debate (Silvia et al., 2008).

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DT has grown in popularity as a tool for testing cognitive and neuroscientific hypotheses about creative thinking (Dietrich & Kanso, 2010; Jung et al., 2013). Many recent laboratory studies of creativity (Fink, Grabner, Benedek, & Neubauer, 2006; Hoffmann & Russ, 2012; Russ & Schafer, 2006; Silvia et al., 2008) focus on the AUT. In addition to that task, some studies have also used the Wallach and Kogan (1965) *instances* task to assess verbal divergent thinking (Benedek, Jauk, Sommer, Arendasy, & Neubauer, 2014; Benedek, Mühlmann, Jauk, & Neubauer, 2013). Participants are instructed to supply as many instances of things with a particular feature (e.g., "things that could be round").

Similar tasks populate the verbal Torrance Tests of Creative thinking (v-TTCT), though the latter include more elaborate tasks like the consequences task—"imagine that humans no longer needed sleep, what would some consequences be?" The figural (i.e. responses are drawn) version of the Torrance Tests of Creative Thinking (TTCT) is more popular with educational researchers assessing the effect of a variety of classroom interventions. Unfortunately, the TTCT are proprietary, costly, and require extensive training to administer and score. In addition, figural tasks require drawing which, in the context of web-based methods, is difficult to assess without specialized equipment. As such, the two studies in this paper used verbal tasks from the WKT. Participants responded by writing or typing ideas, depending upon the different experimental conditions. These methods are consistent with the bulk of current laboratory studies on creativity using DT methods. However, as with other DT tasks, the tasks used in this paper should be considered measures of creative potential, and not necessarily representative of the whole of the creativity construct.

1.2. Improving divergent thinking assessments

Despite the ubiquitous use of DT as a proxy for creative thinking, many have voiced criticism of the method, citing contradictory findings in the neuroscientific DT literature (Dietrich & Kanso, 2010), methodological inconsistencies an contradictory results of studies linking creativity and play (Lillard et al., 2013), and lack of adequate predictive validity (Weisberg, 2006). In addition to examining whether DT can be reliably assessed in using an Internet-based protocol, another central goal of this study was to being to explore ways to overcome some of these criticisms. The two goals are intimately related such that collection of big-data on DT responses using the Internet has the potential to improve the consistency of DT scoring across studies. Specifically, there are a number of issues with the originality scoring procedure known as uniqueness scoring. To do such scoring, researches tabulate the responses given by each participants and award points to responses that are infrequent, or totally unique within the sample. Though the Scholastic Testing Service, responsible for dissemination and central scoring of all of the different versions of the Torrance Tests, compiles response norms for uniqueness scoring, the lists are rarely updated (Kim, 2011). There are no norms for any of the other DT tests, and as previously mentioned, the TTCT norms are proprietary. Thus, web-based DT applications can potentially strengthen uniqueness scoring by offering a central, open-source repository of norms for of various DT tasks.

Scoring procedures could also better reflect the underlying cognitive processes that drive divergent thinking. The collection of larger datasets will facilitate semantic analysis by providing the means to calculate semantic distances between response categories (Gupta, Jang, Mednick, & Huber, 2012), and to use latent semantic analysis and information-theoretic criteria for automatically scoring originality (cf., Forster & Dunbar, 2009; Harbison & Haarmann, 2014). Also, though some studies have analyzed the relationship between response order and creativity (Beaty & Silvia, 2012) DT studies do not measure reaction time, or solution time, two cornerstones of cognitive research on problem solving. One remedy is to examine variables like processing speed and time on task in addition to the traditional fluency and originality scores. This can of course be done in the lab, but a demonstration that the Internet provides another viable option for collecting such data is inherently valuable.

If DT data collected via a web-based system are as reliable as data collected in person, then web-based data collection is a viable option for remedying some of the issues with DT methods just discussed. Study 1 examines this issue by asking whether or not responding (fluency and originality) differed as a function of task setting (in person v. online). Prior studies (Lau & Cheung, 2010) show that DT can be reliably assessed using a computer system, and Forster and Dunbar (2009) reported using a web-based application for DT, but did not directly examine the variations in fluency and originality between the two task settings. As such, Study 1 represents a critical test of whether or not online administration of the AUT hinders responding relative to in-person administration. Prior research has demonstrated that verbal fluency is predictive of DT fluency (Silvia, Beaty, & Nusbaum, 2013), so both verbal and DT fluency were assessed. This enabled the construction of a simple linear model for DT fluency and originality to more accurately assess any differences across the two conditions.

Study 2 examines time on task across conditions in which time limits were imposed on participants and conditions in which no time limits were imposed. Prior research (Wilson et al., 1953) shows that the rate of DT responding is relatively constant over time compared to category fluency tasks (e.g., "name as many animals as possible") in which response rate fades exponentially as a function of time. More recent research demonstrates that originality increases as a function of response order on DT tasks (Beaty & Silvia, 2012), suggesting that the use of time limits may truncate the number of creative responses a person is able to generate. Thus, the second study represents a critical test of the effect of imposed time limits on DT responding over the Internet.

2. Study 1

In the first study, participants' verbal fluency and DT were assessed in person, and online using a simple web-interface created with Qualtrics (www.qualtrics.com). Verbal fluency was included as a control variable as it has been shown to relate positively to fluency on verbal DT items (Benedek et al., 2014; Silvia et al., 2013). Including a measure of verbal fluency also made it possible to test whether the relationship between DT and verbal fluency remained stable across in-person and online groups.

2.1. Method

2.1.1. Participants

Sixty-five participants (32 females) completed the experiment as a part of a requirement for completing an Introductory Psychology course. Participants ranged in age from 18 to 31 years ($M = 19.35$, $SD = 2.17$), and were all enrolled in undergraduate courses at a large suburban university in the Mid-Atlantic region of the US. Data from ten participants in the online condition were excluded from analysis because of failure to follow directions.

2.1.2. Materials

The in-person participants were provided with a packet that included response sheets for all of the tasks along with a small demographic survey. Participants were also provided with pens with which to write responses. Online participants completed the experiment remotely via a custom experimental survey built and