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The relationship between video game use and a performance-based measure of persistence

Matthew Ventura*, Valerie Shute, Weinan Zhao

Florida State University, 1114 W. Call St., Tallahassee, FL 32306, USA

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ABSTRACT

An online performance-based measure of persistence was developed using anagrams and riddles. Persistence was measured by recording the time spent on unsolved anagrams and riddles. Time spent on unsolved problems was correlated to a self-report measure of persistence. Additionally, frequent video game players spent longer times on unsolved problems relative to infrequent video game players. Results are explained in terms of the value of performance-based measures of persistence over self-report measures and how video game use can lead to more persistence across a variety of tasks.

1. Introduction

Evidence is emerging that playing video games is associated with various cognitive and non-cognitive domain general skills. Regarding cognitive skills, playing commercial video games for extended hours has been shown to enhance of visual–spatial skills (Green & Bavelier, 2007, 2012; see Boot, Blakely, & Simons, 2011 for null results) and attention (Boot, Kramer, Simons, Fabiani, & Gratton, 2008). Additionally, video game use has been found to be positively related to GPA (Skoric, Teo, & Neo, 2009; Ventura, Shute, & Kim, 2012), as well as negatively related to GPA (Jackson, von Eye, Fitzgerald, Witt, & Zhao, 2011). In the non-cognitive realm, video game use was found to be positively related to openness but negatively related to conscientiousness in college students (Ventura et al., 2012). Additionally, the relationship between video game use and personality was investigated in middle school children (Witt, Massman, & Jackson, 2011) as well as in college samples (Chory & Goodboy, 2011). Regarding middle school students, those who were higher on openness reported higher levels of video gameplay than students lower on openness. Regarding college students, those who played violent video games were higher on openness and extraversion, but actually lower on neuroticism compared to students who played non-violent video games. Video game use has also been found to be associated with creativity as measured by the Torrance Test of creativity (Jackson et al., 2012). Playing violent video games can actually reduce violent behavior (Ferguson, Colwell, Mlacic, Milas, & Miklousic, 2011) and has been shown to be associated with pro-social skills and increased stress tolerance (Ferguson & Garza, 2011; Ferguson & Rueda, 2010). Recently, a randomized study on violent video games found no effect on depression, hostility, or visual spatial cognition (Valadez & Ferguson, 2012). Finally, research showing negative effects of violent video games has been criticized for flawed methodological designs (see Ferguson, 2010; Kutner & Olson, 2008 for a review).

The purpose of this study is to extend this research to see if video gameplay is related to a particular facet of conscientiousness called persistence. Over the past 20 years or so, conscientiousness has emerged as one of the most important personality traits in predicting academic performance (e.g., Poropat, 2009) as well as in various life outcomes (e.g., Roberts, Kuncel, Shiner, Caspi, & Goldberg, 2007). Persistence (i.e., industriousness in Roberts, Chernyshenko, Stark, & Goldberg, 2005; achievement in Perry, Hunter, Witt, & Harris, 2010) is a facet of conscientiousness that reflects a dispositional need complete difficult tasks (McClelland, 1961), and the desire to exhibit high standards of performance in the face of frustration (Dudley, Orvis, Lebiecki, & Cortina, 2006). Perry et al. (2010) suggest that persistence may

* Corresponding author. College of Education, Suite 1208C Stone Building, 1114 West Call St., Florida State University, Tallahassee, FL 32306-4450, USA. Tel.: +1 609 851 0767.
E-mail addresses: mventura@fsu.edu (M. Ventura), vshute@fsu.edu (V. Shute), weinan.zhao@gmail.com (W. Zhao).

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drive the predictive validity of conscientiousness and is the facet that consistently predicts a variety of outcomes (Dudley et al., 2006; Perry et al., 2010; Roberts et al., 2005) over other facets of conscientiousness.

One way video games may affect persistence is through the principle of challenge imposed in video games (Pausch, Gold, Skelly, & Thiel, 1994). Challenge entails adjusting the optimal level of difficulty for a player and is consistent with the theory of the zone of proximal development (Vygotsky, 1978), which states that learning takes place right at the outer edges of one's abilities. The principle of challenge is pervasively used in video games and has been shown to engage attention and enhance learning (Lepper & Malone, 1987; Rieber, 1996; Sweetser & Wyeth, 2005). Thus video games can be seen as vehicles for exposing players to increasingly more challenging problem-solving activities (Ventura et al., 2012). This repeated exposure to challenge can affect persistence requiring a willingness to work hard despite repeated failure. We begin by describing a new performance-based measure of persistence. Then we investigate how our new measure is related to a traditional measure of persistence as well as to video game use.

2. Performance-based methods to assess persistence

While much attention has been given to facets of conscientiousness, there is much less research on identifying alternative methods to assess facets of conscientiousness. Most of the studies investigating conscientiousness use self-report measures which have a number of problems. First, self-report measures are subject to "social desirability effects" that can lead to false reports about behavior, attitudes, and beliefs (see Paulhaus, 1991). Second, test-takers may interpret self-report measures differently (e.g., *I work hard*) leading to unreliability and lower validity (Lanyon & Goodstein, 1997). Third, self-report items often require that individuals have explicit knowledge of their dispositions (e.g. Schmitt, 1994).

Eisenberger and Leonard (1980) developed a performance-based assessment of persistence using a perceptual comparison task. In this task, the individual was asked to detect as many differences as possible between two pictures. Points were given for each difference found between the two pictures (up to six possible points per pair). The amount of time spent on each pair was intended to measure persistence. Eisenberger and Leonard used this perceptual comparison task to evaluate whether persistence can be improved. Participants were randomly assigned to solve impossible, hard, or easy anagrams and then take the perceptual comparison task. Participants in the impossible anagram condition spent the most time on the perceptual comparison task, followed by those in the hard anagram condition, and finally those in the easy anagram condition. The authors concluded that initial failure in one task (unsolvable anagrams) increases subsequent effort on another task. That is, when individuals are required to exert high effort in one task, they will continue to exert high effort in a subsequent task (see Eisenberger, 1992 for a review). Inspired by this work, we developed a new performance-based assessment of persistence.

2.1. Anagram Riddle Task

The Anagram–Riddle Task (ART) is a performance-based measure of persistence that measures how much time participants spend on hard problems. The ART is administered online (in an Internet browser) and presents hard and easy anagrams and riddles one at a time over a series of trials. Individuals type in their response for the anagram or riddle into a text box and press the "guess" button. If the answer is wrong, the screen displays "incorrect" and the individual can try again (for up to 120 s). At any time the individual can also choose to select the "skip" button to leave the current trial and go on to the next one. If the individual guesses correctly, the person is told that he or she is correct, and is presented with a new trial. A trial is classified as "solved" if the person accurately solves the trial. A trial is classified as unsolved if the person skips the trial or is timed out after 120 s. The reason why we did not use Eisenberger and Leonard's (1980) perceptual comparison task is that we wanted a task that would be difficult enough to compel participants to skip a problem. This is important as we wanted to see the extent to which people persist on hard problems when given the choice of not persisting. Additionally, we wanted an open-ended task that could not be easily guessed.

There are several potential advantages the ART has over traditional self-report measures. First, the ART can be seen as an implicit measure since no explicit questions are used that may cue the intentions of the assessment. This can mitigate the social desirability effect. Second, the ART can be claimed to have greater face validity than self-report measures. Self-report measures of persistence merely ask individuals how they act in difficult problems (e.g., *I never give up*), while performances-based assessments can actually measure behavior in real time on difficult problems. Finally, by nature of their implicit nature and face validity, the ART can offer a framework to assess learning of the target construct over time. For example, assessing the effectiveness of an intervention that tries to improve persistence might be compromised by using self-report measures (e.g., social desirability effects, different interpretation of items, lack of explicit knowledge of dispositional change). Alternatively, the ART may represent a more appropriate means to evaluate if persistence can be affected due to an experimental manipulation or lifestyle choice (e.g., playing video games).

3. Hypotheses

The theory of conservation of resources states that individuals only exert above normal effort in cases where it is deemed to be needed (Hobfoll, 1989). As others have claimed (Perry et al., 2010) we propose that persistence may motivate individuals to expend extra effort in solving hard problems outside of their ability. Specifically, the critical information in the ART that informs the assessment of persistence is *time spent on unsolved trials*. We make the following hypotheses about performance in the ART:

3.1. Hypotheses

1. *Time spent on unsolved trials will be positively related to a self-report measure of persistence and GPA*. More time spent on unsolved trials should be a behavioral manifestation of persistence. Unsolved trials are, by their nature, difficult and thus provide a good context for assessing persistence. While time spent on solved trials is likely a function of persistence as well, it may be dependent on background knowledge and heuristic learning in solving anagrams and riddles in the ART.

2. *Video gameplay will be positively correlated with time spent on unsolved trials in the ART.* Individuals who play video games frequently should have higher persistence compared to individuals who play less frequently or not at all. This hypothesis is consistent with Eisenberger's (1992) work that shows individuals who are assigned tasks requiring high effort (in this case playing video games) will continue to exert high effort in future tasks (e.g., performance in the ART).

4. Method

4.1. Measures

4.1.1. Self-report persistence

Four self-report items were taken from the International Personality Item Pool that were intended to measure persistence on specific tasks. Care was taken to avoid items that were broad in nature, so we selected items that targeted performance relative to difficult problems (*I have patience when it comes to difficult problems, I get easily frustrated on new problems, I tend to avoid difficult problems, I put little time and effort into my work*). Reliability was high among the items ($\alpha = .83$).

4.1.2. Gender and GPA

Self-reported gender and grade-point average were collected.

4.1.3. SAT scores

Self-reported verbal SAT scores were obtained.

4.1.4. Video game usage

Students were asked to answer two questions about their gameplay history: (a) On average, how many hours a week do you play video games? and (b) How many different video games do you typically play in a year?

4.1.5. Sample and procedure

102 undergraduate students enrolled in educational psychology courses at the Florida State University participated in the study. The majority (81%) of the sample was female ($n = 83$). Students took all of the assessments and the ART online on their own time (see Appendix A for the full set of stimuli for the ART). The instructions for the participants informed them to solve as many anagrams and riddles as possible. Participants were also told that some anagrams and riddles will be more difficult than others and if they cannot solve the anagram they have the option to "skip" the trial and go to the next trial. Participants were not given a time limit but there was a 2 min limit on each trial. If the 2 min limit was reached the person was presented with the next trial.

The ART consists of 28 anagrams and 20 riddles. Among the anagrams, 12 are hard and 16 are easy, where difficulty level was determined via pilot work. This particular ratio was used since we wanted to include as many hard trials as possible without frustrating participants. The hard anagrams (e.g., *digamy*) were derived from rare words obtained from a dictionary. Since an anagram is just a string of jumbled letters, searching them on the web does not yield answers. Among the riddles, 12 were hard and 8 were easy (determined via pilot work). All the riddles (e.g., *What is always on the move but never in the past or future? Current*) were homemade to ensure subjects would not look up answers on the web. The purpose of including both easy and hard anagrams and riddles was to ensure that the participants would not get too frustrated which could be detrimental to persistence (Eisenberger & Leonard, 1980). Additionally, hard trials are not intended to be solved but indeed can be solved. Hard and easy trials were presented in alternating order to ensure individuals were not presented with too many difficult trials consecutively. Trials were presented in four blocks (ABCD) that were counterbalanced among participants.

5. Results

To account for the high variability among trial times in the ART, a log transformation was computed on all trial-time data. In addition to the trial-time data, we also recorded the number of trials that were successfully solved for anagrams and riddles. Anagrams ($M = 18.27$, $SD = 3.29$) were solved significantly more than riddles ($M = 4.62$, $SD = 2.90$; $t(101) = 40.43$, $p < .001$). Unsolved anagrams times were not significantly different from unsolved riddle times, yet solved anagram times were significantly shorter than solved riddle times ($t(93) = -16.14$, $p < .001$). Over the sample, hard trials had a solve rate of 24%, while easy trials had a solve rate of 95%.

As can be seen in Table 1, unsolved trial times are significantly correlated to the self-report measure of persistence (self-p). Thus the longer a person spends on an unsolved (difficult) problem, the higher the self-reported level of persistence. Solved trial times, as well as the

Table 1
Correlations among the ART and outcomes.

	Unsolved times	Solved times	Trials solved	Self-p	SAT	GPA
Solved times	.72**					
Trials solved	.65**	.51**				
Self-p	.24*	.14	.17			
SAT	.07	−.03	.10	.26*		
GPA	.08	.00	.19	.16	.39**	
Video game use	.23*	.14	.02	.11	.00	.01

* = $p < .05$; ** = $p < .001$.
Note: Anagrams and riddles were collapsed since they were highly correlated ($r = .78$).

number of trials solved, are not significantly correlated to self-p. Solved and unsolved trial times are significantly correlated to number of trials solved. Finally, solved and unsolved trial times, and the number of solved trials are not related to verbal SAT scores.

We recoded the two video game questions into two categories: no video game use (reported values equal to 0) and video game use (reported values greater than 0) since the distributions for these two questions were highly non-normal. The correlation between the two recoded questions was moderate ($r = .54$). We then took the sum of the two video game questions to obtain a three-point score (0, 1, 2) representing no video game use, moderate video game use, and high video game use (called Video game use in Table 1). As can be seen, Video game use is significantly related to unsolved trial times (hours a week: $r = .23$, $p < .05$; games a year: $r = .21$, $p < .05$). To ensure the Video game use variable was not just a measure of gender, we computed a partial correlation between Video game use and unsolved trial times controlling for gender. This relationship was still significant ($r = .25$, $p < .05$).

An ANOVA comparing the mean log times for unsolved times across the three levels of Video game use showed that people reporting high video game use had significantly longer unsolved trial times than people reporting no video game use ($F(2, 99) = 3.33$, $p < .05$). A Bonferroni post-hoc test confirmed a significant difference between high video game use and no video game use ($p < .05$). The effect size between high, and no video game use on unsolved trials is moderate/high ($d = .59$). Finally, self-p does not relate to GPA or video game use but does relate to verbal SAT scores.

We also explored the time spent on unsolved trials over time as a function of persistence from self-p scores. Since participants had varying amounts of unsolved trials, we focused on trials 1–22 which allowed us to maintain roughly 80% of the sample. We found a significant main effect of decreasing time for unsolved trials ($F(20, 54) = 4.90$, $p < .05$). That is, the effort expended on unsolved trials decreased over time across the sample. This main effect did not interact with self-p or the video game use variable, suggesting that the negative slope on unsolved problems is the same across different levels of video game use and persistence. Fig. 1 displays the decreasing amount of time spent on unsolved trials over time for high, medium, and low persistence (self-p split into three groups). This effect may be due to increasing fatigue over the ART. Another possible explanation for the trend is participants became better at managing their time for trials they knew they could not solve.

6. Discussion

Hypothesis 1 predicted that the amount of time one spent on unsolved trials in the ART would be positively related to a self-report measure of persistence and GPA. We found that more time spent on unsolved trials in the ART was significantly correlated to self-p. As far as we know this is the first study to show the validity of a performance-based measure of persistence. Time spent on solved trials and number of solved trials was not related to the self-p probably as a result of these trials measuring the background knowledge of participants (e.g., differential verbal skills). Additionally, unsolved and solved trial times are significantly correlated to the number of solved trials. This may be because of the bi-directional relationship between performance and time spent on trials. That is, more time spent on trials leads to better performance, and better performance increases the desire to persist longer on trials.

The significant, but relatively low relationship between time on unsolved trials and self-p could be due to a number of factors. First, we used a completely different method to assess persistence (i.e., a performance-based measure rather than a self-reported one). For example, a recent study investigating an IAT (implicit association test) measure of conscientiousness found no relationship between IAT conscientiousness and self-report measures of conscientiousness (Vianello, Robusto, & Anselmi, 2010). Thus, the effects of employing different methods of assessment could account for the low correlation between the two measures. Second, a performance-based measure could be measuring more construct relevant variance regarding persistence than a self-report measure. That is, performance-based measures may be

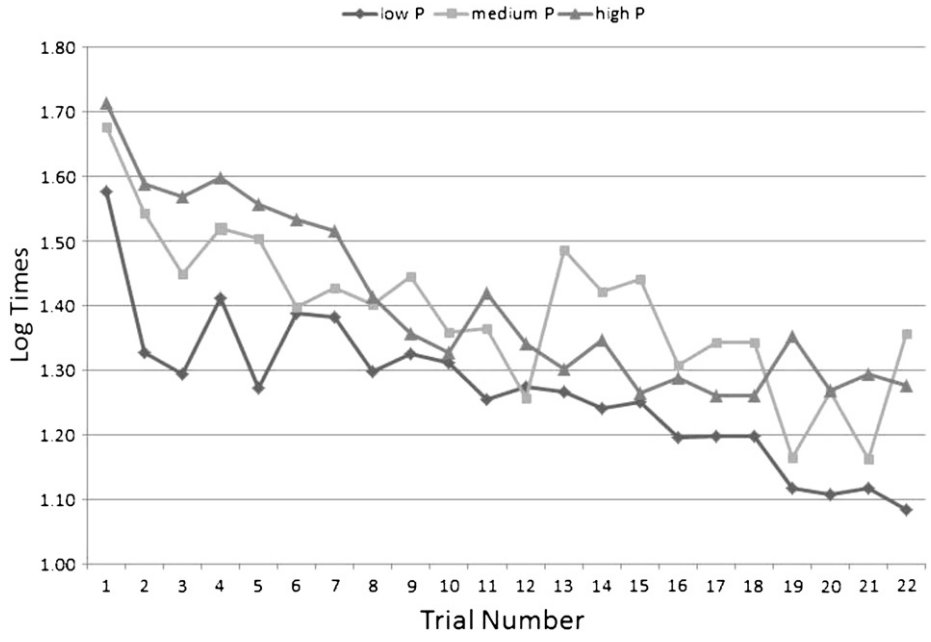

Fig. 1. Mean log time spent on unsolved trials over time for low, medium, and high persistence.

less susceptible to social desirability effects due to the implicit nature of the ART assessment (i.e., students had no idea that they were being assessed for persistence). Moreover, the ART can be claimed to have greater face validity than self-report measures of persistence given that the theoretical definition of persistence (effort expended on difficult tasks) is very similar to the measure itself (time spent on hard, unsolved trials).

While we did show that the ART is related to a self-report measure of persistence, we did not show that either measure of persistence was related to GPA. The lack of relation could be due to the smaller number of items used in the self-report measure (4 items) relative to other studies investigating conscientiousness. Additionally, in the present study we only focused on a particular facet of conscientiousness instead of a global measure of it. Measuring just one facet of conscientiousness might not be sufficient to predict GPA. Future work should consider other outcome measures in evaluating the predictive validity of the ART.

Hypothesis 2 stated that video game use (i.e., hours played per week and games played per year) would be correlated with time spent on unsolved trials in the ART. This hypothesis was confirmed. The results showed that playing video games is associated with greater persistence in a task outside of playing video games. This finding is consistent with Eisenberg's (1992) work that shows individuals who are assigned tasks requiring high effort will continue to exert high effort in future tasks. Thus persistence may be a disposition acquired in video games that transfers to behavior outside of video games. This finding is contrary to recent work that found video game use was negatively associated with a global measure of conscientiousness (Ventura et al., 2012). However, in the current study, we focused on a facet of conscientiousness (persistence) that we believe is more tightly related to playing video games. Ventura et al. (2012) used a global measure of conscientiousness that assesses many facets (e.g., time management, organizational skills), some of which may indeed have negative relations to video game use.

7. Limitations and future work

Since this is a correlational study, we cannot conclude that playing video games causes individuals to become more persistent. Individuals who play more video games may in fact already be more persistent which leads them to play more video games. Future work should focus on experimental studies investigating the causal relationship between playing video games and persistence. Additionally, there was high variation in video game use in the current study. This was primarily found more in females than in males in the sample. Future work should consider having more balance in gender in the sample.

Regarding the ART, there are a number of improvements that should be made. First, the riddles may have been too difficult which may have discouraged participants. As mentioned, the mean number of riddles solved was 4.6 out of 20. This may have frustrated participants leading them to give up trying to solve the riddles. However, the high difficulty could have served as a good discrimination task between individuals with high and low persistence. Having too many trials that were too easy might not discriminate high and low persistence because not enough effort would be required. Future work should systematically investigate how repeated failure in trials affects validity of the ART. Second, the number of unsolved trials in the ART varies among participants (i.e., higher performers had fewer unsolved trials). This can lead to non-normal distributions of unsolved trial times. Future investigations of the ART may consider having a set of "impossible" trials that cannot be solved by anyone (e.g., pseudo-word anagrams). This would (a) ensure that all participants had a core set of unsolved trials, (b) enable reliability analysis among unsolved trials in the ART, and (c) potentially lead to more normal distributions over the unsolved trials for a participant.

Another interesting modification to the ART would be to provide more variation among tasks. Future work should consider incorporating other problem types not related to verbal ability. While we did not find that performance on anagram or riddles was related to SAT verbal scores, we feel including additional perceptual tasks might yield more accurate estimates of persistence. Finally, future work should continue to investigate the incremental validity of the ART over self-report measures.

8. Conclusion

This study provides evidence of the validity of a performance-based assessment of persistence. The ART potentially has a number of advantages over self-report measures. First, the ART appears to have greater face validity since its measurement is based on behavior not self-report. Second, the ART can be seen as an implicit measure since no explicit cues are given regarding the purpose of the assessment. Third, the ART can have useful purposes in assessing the improvement of persistence. Improving student persistence could be useful in increasing motivation in courses that historically have been difficult for students.

This study also continues the emerging trend showing that playing video games are related to positive outcomes. In particular we showed that playing video games is associated with higher persistence in a performance-based measure. This is meaningful considering there is still a stigma that playing video games can lead to poor academic performance.

Appendix A. Anagram–Riddle Task for measuring persistence

Instructions

In this task you will be asked to solve 28 anagrams. Anagrams are a string of letters that can be reordered to make a word. For example, YBO would be an anagram for BOY. Your task is to rearrange the letters into a word and type in your guess. Some words will be harder than others but try to do your best to make a word out of the anagram. All of the anagrams are homemade so you will not find any answers online.

You will also be asked to answer 20 riddles. Some words will be harder than others but try to do your best to give the correct answer. All the riddles are homemade so you will not find any answers online.

If you are having too much trouble with an anagram or riddle, you can skip it by clicking on the skip button. Please do not ask for help from friends. We will give you three warm up anagrams. After the warm up anagrams you will be given the anagrams and riddles split up into four blocks.

Block 1 – click next to answer 7 anagrams			
Trial	**Riddle/Anagram**	**Answer**	**Difficulty**
1.	lalb	ball	Easy
2.	norb	born	Easy
3.	diyamg	digamy	Hard
4.	yaaw	away	Easy
5.	wopneg	gowpen	Hard
6.	bluc	club	Easy
7.	hamyap	mayhap	Hard
	BREAK – click next to answer five riddles		
8.	What can you get in and out of without going anywhere?	trouble	Hard
9.	What gets walked on and walks on things?	shoe	Easy
10.	What can be wet and on fire at the same time?	athlete	Hard
11.	What starts off with a tail and ends with two legs?	frog	Easy
12.	You can take me and be in me. I can also be attracted to myself. What am I?	charge	Hard
Block 2 – click next to answer 7 anagrams			
Trial	**Riddle/Anagram**	**Answer**	**Difficulty**
1.	cytepl	yclept	Hard
2.	leph	help	Easy
3.	moeh	home	Easy
4.	styrt	tryst	Hard
5.	fels	self	Easy
6.	libee	belie	Hard
7.	nair	rain	Easy
	BREAK – click next to answer five riddles		
8.	What can be broken but still work?	heart	Easy
9.	What can be happy but is not a living thing?	hour	Hard
10.	Where can you go up but not get higher?	alley	Hard
11.	What can you catch but not throw?	cold	Easy
12.	I can be crossed. I can be dropped. I can be spoken. What am I?	line	Hard
Block 3 – click next to answer five riddles			
Trial	**Riddle/Anagram**	**Answer**	**Difficulty**
1.	You see through me but you don't see me. What am I?	eye/eyeball	Hard
2.	I can be cracked, I can be made. I can be told, I can be played. What am I?	joke	Hard
3.	What grows but is not alive?	hair	Hard
4.	What is loud but does not bother people?	headphones	Easy
5.	What goes up and down the stairs without moving?	rug	Easy
	BREAK – click next to answer 7 anagrams		
6.	nawt	want	Easy
7.	kamasd	damask	Hard
8.	vome	move	Easy
9.	nairc	cairn	Hard
10.	lyap	play	Easy
11.	spey	espy	Hard
12.	nidk	kind	Easy
Block 4 – click next to answer five riddles			
Trial	**Riddle/Anagram**	**Answer**	**Difficulty**
1.	I'm light as a feather, yet the strongest man can't hold me for much more than a minute. What am I?	breath	Hard
2.	I can't be seen but can be swallowed. What am I?	pride	Easy
3.	What is always on the move but never in the past or future?	current	Hard
4.	What takes 1000s of workers to build but can be easily destroyed?	anthill/ant hill	Hard
5.	Everyone likes them but nobody wants to see them. What am I?	doctor	Easy
	BREAK – click next to answer 7 anagrams		
6.	getlim	gimlet	Hard
7.	letl	tell	Easy
8.	toey	eyot	Hard
9.	nomo	moon	Easy
10.	darc	card	Easy
11.	hethy	hythe	Hard
12.	lewl	well	Easy

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