

**The effects of grit, conscientiousness, and question order of unsolvable problems on subsequent performance.**

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Submitted in partial fulfilment of the requirements of the Higher Diploma in Arts in Psychology at Department of Psychology, DBS School of Arts, Dublin.

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April 2013

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## Acknowledgments

A sincere thanks to my supervisor Dr Barbara Caska for her support, to the lecturers in DBS for their time and attention and to my classmates for their support and help. Thanks to my friends, especially Vincent Murphy, for helping in data collection and spreading the word on the test. Finally, a special thanks to my partner, Emma Scott, for her patience and understanding while I wrote this.

**Abstract**

This experiment looks at the effects of uncontrollable repeated failure, task order, grit and conscientiousness on problem solving performance in terms of accuracy or time spent. The online test compared two randomly assigned groups, one with insolvable problems at the beginning and the second group with them in the middle of a series of number sequencing problems (n=316), with a view to learning the predictive effect of grit and conscientiousness and the effects of task order. There was not a significant difference in the accuracy or effort expended on subsequent problems in either group. Conscientiousness and grit were not predictors of the performance level but conscientiousness correlated positively with completion of the task. The Short Grit scale was not a predictor of task completion. Task order had no significant effect on the performance and the results did not fit with classical or cognitive theories of learned helplessness.

## **1.0 Introduction**

Here I shall give the background to the study and some historical background on the basis for the study as well as an overview of current theories and thinking on the matter in question. This section will be structured this into five parts; firstly, there will be a discussion of relationship of unsolvable problems to subsequent performance on a cognitive task, looking at literature from the field of learned helplessness and at cognitive theories of explanations of subsequent performance. The second section will look through the research and rationale for the ordering of the tasks or questions in the test to see how this effects subsequent performance looking at what has been worked on in this area before. In the third section, there will be a review of the literature comparing problem solving and perseverance, with a focus on unsolvable problems and in the next section it will cover the literature on conscientiousness and how this affect persistence with unsolvable problems. In the final section hypotheses that can be tested in the research will be drawn out and a rationale provided for these.

### **1.1 Performance on problems following unsolvable problems.**

There is a large body of work on how unsolvable problems can impair further performance, from both the work of Seligman (1975) on learned helplessness and a number of subsequent works on the areas of control motivation theory and cognitive theories of learned helplessness. Bainbridge's (1973) work on animals showed that exposure to an unsolvable task lead to poorer subsequent performance on solvable task, which could be classified as a generalised learning deficit purely down to early exposure to unsolvable tasks. Later, Abrahamson, Seligman and Teasdale (1978) transferred these models of learned helplessness into human study are of the view that the subsequent decrease in performance is down to learned helplessness. They defined 'Learned Helplessness' effect on future performance as follows:

...the attribution led to an expectancy of non-contingency between future acts of the individual and the outcome. Finally, the symptoms of helplessness were a consequence of the person's expectancy that his future responses would be futile in obtaining the outcome. (Abramson, Seligman, & Teasdale, 1978)

This would indicate that a person who suffered from learned helplessness would lack the motivation on subsequent problems and would spend less time on these and that accuracy would be diminished on these because of this.

This theory had critics and there were other who raised the possibility of performance being affected by a number of other factors such as egotism (Frankel & Snyder, 1978). Frankel and Snyder (1978) work focus on the difficulty level of the following problems, where subjects performed better if they were told the problems were very difficult rather than moderately difficult and where failure would pose fewer risks to their self-esteem and ego by failing at them. Research on learned helplessness held that this was not the case and was dependant on the non-contingency of the correct result to the effort. Comparisons of the two approaches by Kofta & Sedek (1999) and Snyder, Smoller, Strenta, & Frankel (1981) backed the learned helplessness approach in experiments comparing the two.

There were also contradictory findings, which have seen initial improvement on the problems after the unsolvable problems (Mikulincer, 1988). Mikulincer (1988) saw there were differences in the performance in subsequent questions depending on the number of questions that were unsolvable and the Attributional bias of the subject; internal attributors did better after one unsolvable problem but external attributors did better after four unsolvable problems. Mikulincer (1988) referenced findings by Pittman & Pittman (1979) that a small level of failure aided performance but prolonged exposure caused helplessness. To measure the level of prolonged exposure required, Mikulincer (1994), quoted in Ric & Scharnitzky (2003), conducted

one of the few experiments that measured the number of unsolvable problems presented before a reduction in performance became apparent and he discovered that three was where the performance began to deteriorate.

Ric & Scharnitzky (2003) also discussed the motivational control theories (Pittmann & D'Agostino 1985/1989), which stated that exposure to uncontrollable events such as unsolvable problems leads a desire to increase the subject's level of control, which can subsequently lead to a lowering of performance as it leads to greater time being spent on studying all possible options in the tasks. However, in the case of failure as would be the scenario in this experiment, then the effects depend on the nature of the task. If it is ego threatening (seen as a measure of an important ability to the subject), then they are expected to reduce effort in the test so that have a readymade excuse for the subsequent failure and the reverse for non-ego threatening situation (Ric & Scharnitzky, 2003). The set up in this experiment will not be able to measure the ego threatening nature of the test, so it will not be possible to measure this possible explanation and for the same reason, it would not be possible to verify Frankel & Snyder's results (1978).

The other two approaches that we can look at in this experiment are the remaining two possible theories for explaining the reduction in performance after unsolvable problems. Firstly, the classical learned helplessness approach (Abramson, Seligman, & Teasdale, 1978) would suggest that the reasons for performance reduction would be down to a lack of motivation caused by the lack of contingency between effort and result. This would cause the amount of time spent on the questions as well as the accuracy to reduce due to lack of motivation. The second explanation, the cognitive theories of learned helplessness (Mikulincer, 1989), would suggest that the unsolvable problems would reduce the levels of correct answers due to a cognitive interference but that the time spent on the questions would not be affected, showing that it is eventually cognitive exhaustion that causes the decrease in performance. In this scenario, the

time spent on the problems should increase or stay the same but without any improvement in performance.

## **1.2 Task order effects on subsequent performance.**

The ordering of unsolvable tasks in a sequence is an area that is relatively under-research with most of the literature concentrating how people deal with failure to solve a problem and subsequent performance and non-failure as a control group (Mikulincer, 1990, 1994, Horatio & Seligman, 1975, Ric & Scharnitzky, 1975). This has meant that there is a lack of knowledge on if and by how much initial success and failure can influence further performance. One of the main papers that looked at the area of was that of Ric & Scharnitzky (1993), which built on the work of Mikulincer (1990, 1994), which measured the number of questions that needed to be used in a group to cause a group to suffer from a fall in subsequent performance. It produced a number of a number of interesting results depending on the number of problems presented to the test subjects. It was demonstrated that that the original theory of learned helplessness which would have predicted that a lower number of unsolvable problems would have led to an increase in motivation and higher levels of unsolvable problems would lead to a reduction in motivation and less effort but this was not borne out by results (Ric & Scharnitzky, 2003). Similarly, Kofta and Sedek (1999) and the motivation control hypothesis would have predicted a great cognitive effort being expanded as more unsolvable problems were introduced but this too was not proven.

However, it can be seen that their research that there was a difference in the accuracy in the task as the number of unsolvable problems were increased, with those who encountered six or eight unsolvable problems in the test showed significantly poorer accuracy which would be in line with learned helplessness theories and refute the control motivational theories.

They also pointed out that the task order of the test had a significant effect and there was an interaction between the number of problems and the task order (Ric & Scharnitzky, 1993).



Their paper did not see these as an important feature of the research and these findings were not discussed any further but this leaves an important part of the discussion open. They had observed a change in the performance depending on whether the subjects were presented with two or four-letter task first and this would seem to suggest that the cognitive demands and difficulty and the positioning of these tasks in the test had an important bearing on the results.

This paper will attempt to look at this gap in the research, which has not been addressed. It will also attempt to do this in a more ecologically valid way. Firstly, by making the setting more realistic by having it in a normal PC environment rather than a laboratory, it should lead to results that will be more generalizable and useful in an applied sense. Secondly, by avoiding the change in the type of tasks presented that is common to all the research that I have looked at (Ric & Scharnitzky, 1993, Hiroto & Seligman 1975, Mikulincer 1989, 1990) should mean there is less chance of this causing the performance deficit. This is caused by the fact that the change of the control processes that occurs for a task switch (Monsell, 2003). The switching of tasks can cause a subject's responses to be slower and usually more error prone after a change of task according to Monsell (2003), which could result in a cost in performance in the subsequent task, which I have termed the switch cost. Although the experiments listed above give the subjects chances to prepare for the switch, which will allow them to reduce the effects of the switch cost, this switch cost is not fully eliminated and could be a possible partial cause for the reduction in performance rather than the effects of task failure on the unsolvable problems. Monsell (2003) also points out that it is easier to switch from the stronger to the weaker of the two tasks but in a number of the experiments, the secondary task could be judged as equally taxing, which would seem to add additional room for error into the measurements.

In integrating the unsolvable questions into the body of the test, it should reduce the effects of this switch cost as well as allowing a more realistic example of task completion. Ric & Scharnitzky (1993) also proposed that the effects of failure only became apparent in reduced

performance and effort once there were more six or more unsolvable problems, while these effects were not noticeable at up to four unsolvable problems whereas other studies (Hiroto & Seligman 1975, Mikulincer 1989, 1994, Kofta & Sedek, 1999) produced an effect after three unsolvable questions.

### **1.3 Grit as a predictor of performance.**

In looking at unsolvable problem and perseverance, there were a large number of reasons as to why people persist with problems solving after failure. This work covered a wide number of areas such as self-awareness and attribution style (Kernis, Zuckerman, Cohen, & Spadafora, 1982, Mikulincer, 1994), where the Attributional style and the number of questions affected performance, egotism (Frankel & Snyder, 1978) which stated that the ego threatening level of the test affected performance, and coping strategies (Mikulincer, 1989), which had different effects for emotional or problem focused coping strategies. In looking at the research in this area, few had looked at traits that could be relevant to the completion of the subsequent problems such as grit or perseverance when used as a predictor variable for dealing with learned helplessness. The short grit scale (Duckworth & Quinn, 2007) provided a measure of this and in doing the study, it could be tested against how effective it is as a predictor of ability to complete tests with unsolvable answers.

In their work on the Grit-S scale, Duckworth and Quinn, (2007) mention the fact that it is mainly used to perform long-term perseverance of effort across a long-term task such as completion of training programs at WestPoint Naval academy or competing in the National Spelling Bees in the United States. Based on their studies on the perseverance of effort and how good a predictor that this would be for completion of the test in particular, whereas the consistency of interest was of less interest as it is mainly for longer-term goals. They also raised

considerations as to whether Grit or Conscientiousness from the Big Five Inventory would be the more accurate in predicting the completion of the tasks and on time spent on the tasks.

Duckworth and Quinn (2007) acknowledge that the two traits are correlated but they have a gap in their research around the prediction capabilities of the Grit-S scale when assessing completing of shorter-term goals or tasks and when faced with uncontrollable situations, so part of this test would be to measure how useful it was in testing in these circumstances. It would also allow a comparison with predictive value of Conscientiousness on this task, as the research on Grit

“Are often developed without much mention of conscientiousness, clearly each shares core elements with facets of the trait” (Roberts, Lejuez, Krueger, Richards, & Hill, 2012).

#### **1.4 Conscientiousness as a predictor of performance**

Overall, a large number of variables that have been measured in these experiments in relation to unsolvable problems and learned helplessness and it is difficult to compare like with like across studies to do a meta-analysis. Some have, as already discussed, concentrated on the self-esteem invested in the tasks (Frankel & Snyder 1978) while some have looked at Narcissism (Wallace, Ready & Weitenhagen, 2009). Others have varied the number of questions required and the coping strategies used (Ric & Scharnitzk 2003, Mikulincer 1989). However, the Big Five personality traits (John & Srivastava, 1999) are the basic building blocks of personality research and how these relate to problem solving is an area that would seem to be ripe for research. According to Gellatly (1996) there is a wide area of research on the relationship between personality trait of conscientiousness and work outcomes such as salary level, promotions, tenure and turnover (Barrick et al., 2001) but there is less information available about how conscientiousness correlates with actual task performance. For studies that do look at this area,

there seems to be a definite relationship between the trait conscientiousness and task based conscientiousness (Minibashian, Wood & Beckmann, 2010) but this is all focused on performance on solvable and achievable tasks. The researchers here also point out that there is considerable variance in this depending on the difficulty and urgency of the task that people are directly engaged in (Minibashian et al., 2010).

Minibashian et al. (2010) also discovered in their research that in addition to the trait conscientiousness being positively correlated with task conscientiousness that the difficulty of the task in hand was correlated with the level of task-based conscientiousness. Their research also found a significant behavioural effect with those who were high on trait conscientiousness were also higher on task-based conscientiousness, regardless of the task difficulty. This approach would suggest that this trait would be a good predictor of how much effort and attention a subject would pay to a topic and would also allow us to compare with the Grit scale described above to see if there was a difference between the two and how these two measurements correlated with a task based measure. As a controlling factor, Minibashian et al. (2010) also stressed that the trait conscientiousness was not the sole predictor of task based conscientiousness and that need for cognition played a role in this. As the task-based measure that is being carried out in this study covers an unsolvable problem, we should see it in the higher difficulty scale of tasks, which should activate the trait conscientiousness and need for cognition.

In fact, in researching the area of unsolvable problems and personality traits there was very few areas that had been researched apart from those described above, with no research on the big five personality factors appearing to have been done to see how they correlate to performance on subsequent problems. The area seems to have adequate research in areas such as self-esteem and effort following task failure (McFarlin, Baumeister & Blascovich, 1984) as well as the research papers noted above. In this regard, there is a gap in the literature to see how trait

conscientiousness affect the performance post failure on unsolvable problems and the effort expended on these problems and subsequent problems as well as what effect the ordering of the tasks will have on the conscientiousness of the subjects.

### **1.5 Hypothesis formation**

In looking at the research above, there appears to be a number of areas that are not fully covered by current research that can be addressed by a new study. In particular, there is a lack of conclusive evidence on the reasons for subsequent poor performance following uncontrollable task failure by participants. In conducting research, there is an opportunity to check if participants decrease their performance level on subsequent tasks in the test following failure and if there is any change in their effort expended, measured in time spent on each question.

For this study, I will be using an online survey, consisting of some basic demographic information, the Big Five Index (John & Srivastava, 1999) for measuring conscientiousness and the Grit-S scale (Duckworth & Quinn, 2007). Then there will be random assignment to one of two series of eight questions with mathematical patterns. Details of this can be found in the methodology section below. The first hypothesis will look at the area of performance: **H<sub>1</sub>**: Subjects that encounter unsolvable problems will be affected in their performance on subsequent problems in terms of both correct answers and effort expended.

From looking at the results on the timing and the accuracy, we will be able to see if the classical theory of learned helplessness is more accurate or if the cognitive theory is more correct by measuring the amount of time spent at the impossible questions as they progress and the subsequent questions. This will allow us to frame the second hypothesis:

**H<sub>2</sub>**: The amount of time spent on the questions will increase as they progress through the unsolvable questions and the subsequent questions, in line with the cognitive theory of learned helplessness.

As the research about the sequence of tasks is lacking (Ric & Scharnitzky, 2003), in this study there will be a focus on what effect task order is a factor in subsequent performance for group two compared to group one. Ric & Scharnitzky (2003) mentioned that there was a task order effect in their work, so this data will allow us to compare what effect this will have. The third hypothesis is that: **H<sub>3</sub>**: Subjects that have three unanswerable questions at the start will be less accurate and will spend less time on subsequent problems than those who have the initial solvable questions.

In relation to the Grit-S scale (Duckworth & Quinn, 2007), there is very little research on its application to problem solving or task based work. This will be an opportunity to check if the Grit-S scale is applicable at a task-based level as a predictor of completion of the test and of performance in answering. It is hypothesized that: **H<sub>4</sub>**: Volunteers with higher levels of grit will have higher completion rates of the questions that follow the unsolvable problems and longer time spent but with no difference in correct answers.

In relation to the results from conscientiousness scores, we can see that there is a task based conscientiousness effect from higher scores on the conscientiousness trait test. In the study, there will be an opportunity to measure this result again and see if there is more evidence for trait conscientiousness leading to better performance. It will also be possible to measure how this relates to time spend and correct answers as well as what the effect of unsolvable problems is on this. **H<sub>5</sub>**: Volunteers with higher levels of conscientiousness will have higher completion rates of the questions that follow the unsolvable problems and accuracy and time spent on each question will be higher.

As this is an online study, there will be a risk of people failing to complete the test (Youngju, Jaeho, & Taehyun, 2013) with those with the best locus of control and self-efficacy who were usually seen as the ones most likely to complete. **H<sub>6</sub>**: the variables of grit and

conscientiousness should be significantly different in those that complete the test compared to those who drop out during the questions phase.

This is due to these two variables should most directly relate to their persistence in completing the test. Grit and conscientiousness measures are thought to be broadly similar; there should be a significant relationship between these two variables and the persistence needed to finish the test. Duckworth and Quinn (2009) had mentioned that there was significant long-term effect on grit and that up to the study, it had been used to measure perseverance towards long-term goals, most specifically towards the attainment of educational goals. There had been studies that had looked at grit in light of its relationship to conscientiousness, there appears to be validity in the long-term commitment to goals, but there is less research on the short-term consistency to finish a short, more difficult task (Duckworth, Peterson, Matthews & Kelly, 2007). In this experiment, it will be possible to see if there is a correlation between Grit and Conscientiousness: **H<sub>7</sub>**: There should be significant correlation between grit and conscientiousness measures as they measure similar personality traits and attributes. This will allow us to see what the overall relationship between both is.

## 2.0 Method

### 2.1 Participants

The sample consisted of a convenience sample of internet users drawn from posts on Facebook, LinkedIn and Twitter as well as re-tweets and reposts of the message from friends and some radio journalists. At the close of the survey, there were 407 replies. Of the 407 who had started, 319 had completed beyond the conscientiousness and grit survey questions and started the test, and were deemed usable. Of these 319, three were excluded due to age (they were under 18) and no permission had been received, giving a total valid sample of 316.

Demographically, the group consisted of 166 females with a mean age of 34.60 (and 150 males with a mean age of 35.87. The sample was mainly drawn from Ireland (72.1%), the United Kingdom (11.3%) and Australia (4.4%) with the remaining coming from 15 other countries (See appendix 1).

Group 1 consisted of 160 participants evenly split between male and female and group two consisted of 156 participants with 86 females and 70 males. The average age of group one was 35.67 years and group two was 34.73, both with a standard deviation of 7.2.

In terms of occupation, there was a wide mix with the three largest groups (sales / marketing, education and science / technology) making up just under 35% of the survey and the remaining 65% spread over the other occupations. When broken into groups one and 2, the proportions remained roughly the same as the overall group (see appendix 1).



Table 2.1 *Demographic details of Groups 1 and 2*

Groups	N	Male	Female	Mean Age
1	160	50%	50%	35.67
2	156	44.9%	55.1%	34.73
Total	316	47.5%	52.5%	35.21

Table 2.2 *Demographic details of Completers and incomplete answers.*

Groups	N	Male	Female	Mean Age
Complete	248	47.2%	52.8%	35.0
Incomplete	68	48.5%	51.5%	35.9
Total	316	47.5%	52.5%	35.21

## 2.2 Design of the Research

The research was a between subjects experiment with random assignment to one of the two scenarios below. The aim was to find a correlational relationship between the positioning of the unsolvable problems and the subsequent performance/effort on the test. The independent variables were the allocation of the group to one of either two scenarios—one control group with unsolvable questions first (Group 1) or one experimental with the unsolvable questions in the middle (Group 2). The dependent variables are the results of the eight test questions for time spent (or effort) and the number of correct answers (accuracy or performance). There was also a between subjects experimental design to find a correlation between the scores on the conscientiousness scale and grit scales and the number of questions that people completed

(completion vs. partial completion) as well as their time spent (or effort) and the number of correct answers (accuracy or performance)

### **2.3 Materials**

The self-report questionnaire and test was carried out online using the online survey site [www.surveygizmo.com](http://www.surveygizmo.com) and it was posted online on the 13<sup>th</sup> of February 2013 and closed on the 28<sup>th</sup> of February 2013.

On the first page, there were four questions on gender, age, country of residence and occupation (see appendix 3). The next page brought the person into the conscientiousness questions from the Big Five Index (John & Srivastava, 1999). These were a nine item series of questions measured on a five point Likert-scale questions assessing the participant's conscientiousness, with answers ranging from disagree strongly to agree strongly. The scale is one of the most widely used in personality research and the Cronbach's alpha of this test is .755 (for details see appendix 4). It measures generalized conscientiousness. Using SPSS, a combined score for conscientiousness was computed.

Following these nine questions, there were the eight questions from the Short Grit Scale (Grit-S) (Duckworth & Quinn, 2009). This is an eight-item questionnaire based on a five point Likert scale and has a Cronbach's alpha of .772 (for details see appendix 5). This test measured for the grit of the subject and an average score for grit was computed using SPSS.

The next item was the eight number sequencing questions, which formed the basis of the test. The questions were based on the sample questions from IO Test labs with some edits made by the author to create new questions and create the impossible questions (IQ Test Labs, 2011). They are contained in appendix 6. In the data, the questions were timed in seconds and each question attempted had a time in seconds. The answers were also collated with zero being scored for an incorrect answer and 100 for a correct answer. Averages for these were calculated in SPSS

to give an average time for the three unsolvable questions, for the next two questions, which were solvable, and for the final three. Average scores for these three groups were also completed.

## **2.4 Procedure**

The survey contained an opening page, which outlined the rationale behind the survey and some details on the reasons for carrying it out. They then moved to the demographic information questions mentioned above. Once they completed these and pressed continue, they were brought to the page with the nine item conscientiousness score and the clicking through would bring them to the eight item Grit scale.

The next page advised the participants that the test would follow and that the time spent on each question would be timed (Details are in appendix 7). This was a hidden variable so the participants would not see how long they were spending on each question. There was also an automatic random division of the participants at this stage into the two branches, A and B. These two groups will be ordered as below, so that the performance when the first two questions are solvable can be measured as well as when the first three are insolvable can be taken into account. As the same questions will always follow the insolvable ones, we can see what effect this has.

All questions in both branches were mandatory and it was not possible to go backwards and redo or change questions once they had been answered. A full list of the questions is included in appendix 6.

The questions were presented on a new page for each new question and it was impossible to see the time measurement on each question or to move backwards through the questions once it was complete. After each question, a new page loaded telling the person whether the answer was correct and then they clicked to advance to the next question

Table 2.3 *Order of the questions between Groups A/B*

Group 1	Question Difficulty	Group 2	Question Difficulty
A	Solvable	C	Insolvable
B	Solvable	D	Insolvable
C	Insolvable	E	Insolvable
D	Insolvable	F	Solvable
E	Insolvable	G	Solvable
F	Solvable	H	Solvable
G	Solvable	I	Solvable
H	Solvable	J	Solvable
I	Solvable	A	Solvable
J	Solvable	B	Solvable

Once they had completed the eighth question, they were moved to the debriefing page. As there was a test involved and there was a certainty that those that continued until the end would have answered some of the questions incorrectly, this page described what had been the real reason for the test. It also included a debriefing on the details and a request not to disclose the actual rationale in the process to anyone taking part, so as not to bias future participation. The debriefing page also included details on organisations that they could contact in case of negative affect or if they wished to know more about improving their mathematical literacy. To date, no one who took the test has been in contact in relation to the test. The text of this page is included in appendix 8.

### 3.0 Results

The hypothesis will be listed here with an overview of the results and the statistical analysis that was used. The statistical analysis can be found in the SPSS file attached.

#### **Hypotheses**

**H<sub>1</sub>:** Subjects that encounter unsolvable problems will be affected in their performance on subsequent problems both in terms of correct answers and effort expended.

To compare these two groups, an independent samples t-test was conducted on the answers on questions six, seven and eight (group A), which were after the unsolvable problems and which were before the unsolvable problems in group B. There was no significant difference between these showing that the unsolvable problems had had little effect on performance of these tests. The independent samples T-test was also performed on the individual questions under performance and effort and there was no significant differences here, except for a slight correlation on effort expended on question 6 ( $t(246) = 2.035, p = 0.043, \alpha = 0.05$ ).

**H<sub>2</sub>:** The amount of time spent on the questions will increase as they progress through the unsolvable questions and the subsequent questions, in line with the cognitive theory of learned helplessness.

To verify the amount of time spent on questions, the mean of each of the two groups on each question was calculated:

Table 3.1 *Mean time spent by each group on each question*

Question	Group A average time	Group B average time
Q. 1 group A /4 Group B (1 <sup>st</sup> unsolvable question)	45.18 sec	50.74 sec
Q. 2 group A /5 Group B (2 <sup>nd</sup> unsolvable question)	82.40 sec	93.41 sec
Q. 3 group A /6 Group B (3 <sup>rd</sup> unsolvable question)	99.19 sec	63.43 sec
Q. 4 group A /7 Group B (1 <sup>st</sup> post-unsolvable question)	24.37 sec	21.42 sec
Q. 5 group A /8 Group B (2 <sup>nd</sup> post-unsolvable question)	20.62 sec	16.74 sec
Q. 6 group A /1 Group B (Solvable question)	13.33 sec	11.31 sec
Q. 7 group A /2 Group B (Solvable question)	33.83 sec	19.46 sec
Q. 8 group A /3 Group B (Solvable question)	19.66 sec	18.98 sec

We can see from the results here that on the unsolvable questions, there appears to be support for the cognitive theory of learned helplessness, but this group also includes an outlier that is far in excess of the other values. When this is excluded, the average value drops to 58 seconds, comparable to the group B.

As the effort expended rises and then falls, it does not fit either of the two theories stated and it would appear the difficulty of the question plays a major role in effort expended subsequently.

In relation to accuracy, there is also no significant pattern or differences in the mean. This also applies to the questions 6, 7 and 8, which appear as the first three for group B. This means that they have not experienced the failures on the unsolvable questions but their mean was not significantly different to the group A.

Table 3.2 *Mean accuracy of performance of each group on questions 4-8*

Question	Group A Mean score	Group B Mean Score
Q. 4 group A /7 Group B (1 <sup>st</sup> post-unsolvable question)	93.50	91.54
Q. 5 group A /8 Group B (2 <sup>nd</sup> post-unsolvable question)	95.90	96.85
Q. 6 group A /1 Group B (Solvable question)	97.52	94.49
Q. 7 group A /2 Group B (Solvable question)	85.95	91.34
Q. 8 group A /3 Group B (Solvable question)	94.21	98.42

**H<sub>3</sub>** : Subjects that have three unanswerable questions at the start will be less accurate and will spend less time on subsequent problems than those who have the initial solvable questions.

To access this, two types of analysis were carried out. Firstly, there is a comparison of the completed results analysis using an Independent T-test to establish if there was a significant difference in the correct answers on questions four and five and a difference in the total amount of time spent on these.

An independent samples T-Test for the time spent on the questions after the unsolvable questions showed that there was no significant difference between the two groups ( $t(166.739)=1.457$ ,  $p=0.147$ ,  $\alpha=0.05$ ) and the average score also showed no significant difference at ( $t(246)=0.033$ ,  $p=0.974$ ,  $\alpha=0.05$ ). We can see here that the hypothesis that the unsolvable problems would cause a decrease in cognitive performance was unfounded, those did the unsolvable problems in the middle did not have a significant difference. When we looked at the answers to questions 6, 7 and 8, we can also see that there was no significant difference in either group when we compare these, showing that the cognitive strain of working out the problems did not significantly affect their accuracy.

Table 3.3 An Independent Samples T-test table displaying the differences between groups A and B for these variables.

Variables	Group 1 <sup>st</sup> / 2 <sup>nd</sup>	N	Mean	SD	t	df	p
Average time Q4+5	1 <sup>st</sup>	123	22.70	20.60	1.65	173.18	.102
	2 <sup>nd</sup>	131	19.33	9.92			
Average Score Q4+5	1 <sup>st</sup>	123	23.78	4.64	.085	249	.932
	2 <sup>nd</sup>	128	23.73	4.66			
Timer Question 4	1 <sup>st</sup>	123	24.37	30.60	.988	252	.324
	2 <sup>nd</sup>	131	21.42	14.86			
Timer Question 5	1 <sup>st</sup>	123	93.50	24.76	1.610	139.204	.110
	2 <sup>nd</sup>	130	91.54	27.94			
Answer Question 4	1 <sup>st</sup>	122	20.62	25.68	.589	251	.557
	2 <sup>nd</sup>	127	16.74	7.20			
Answer Question 5	1 <sup>st</sup>	122	95.90	19.91	-.399	247	.690
	2 <sup>nd</sup>	127	96.85	17.53			
Average Time Q6, 7 & 8	1 <sup>st</sup>	121	22.28	53.58	1.157	246	.248
	2 <sup>nd</sup>	127	16.59	13.79			
Average score Q6, 7 & 8	1 <sup>st</sup>	121	34.71	5.93	-1.145	240-210	.253
	2 <sup>nd</sup>	127	35.53	5.32			

Note: p significant at .05 level.

**H<sub>4</sub>:** Subjects with higher levels of grit will have higher completion rates of the questions that follow the unsolvable problems and longer time spent but with no difference in correct answers.

To look at the effect of grit on the group, a correlation was performed between the grit score and the time spend on the questions following the unsolvable ones along with the average score on those questions. There was no correlation between the variables grit and time spent on questions 4+5 [ $r = -0.028$ ,  $n = 251$ ,  $p = 0.711$ ] and there was no correlation between grit and the



average score over the variables ( $r = -0.025$ ,  $n = 254$ ,  $p = 0.662$ ). The reason for the difference in the number of participants  $N$  is three participants who did not enter an answer but stayed on the page for some time before closing.

Table 3.4 *Correlation Table for Grit*

		Grit	Q4+5 time	average Average Q4+5
Grit	Pearson Correlation	1	-.028	-.024
	Sig. (2-tailed)		.662	.711
	N	316	254	251

The original intention was to also test those who completed the test and those who only partially completed the test but there were only six in the partially complete group who managed to get this far.

**H<sub>5</sub>:** Subjects with higher levels of conscientiousness will have higher completion rates of the questions that follow the unsolvable problems and accuracy and time spent on each question will be higher.

To look at the effect of conscientiousness on the group, a correlation was performed between the conscientiousness score and the time spent on the following questions along with the average score on the subsequent questions. There was no correlation between the variables conscientiousness and time spent on questions 4+5 [ $r = -0.106$ ,  $n = 254$ ,  $p = 0.093$ ] and there was no correlation between conscientiousness and the average score over the variables ( $r = -0.055$ ,  $n = 251$ ,  $p = 0.383$ ).

Table 3.5 *Correlation table for Conscientiousness*

		Conscientiousness	Q4+5 average time	Average Q4+5
Conscientiousness	Pearson Correlation	1	-.106	.055
	Sig. (2-tailed)		.093	.383
	N	316	254	251

**H<sub>6</sub>** The variables of grit and conscientiousness should be significantly different in those that complete the test compared to partial completers.

An independent sample T-test was conducted on the two groups to compare completion in groups that fully completed the survey and those that partially completed the survey.

As we can see from the data, there was a significant difference in the scores for completed (M=35.12, SD= 5.35) and incomplete (M= 28.63, SD= 2.61) conditions;  $t(13.967)$ ,  $p=0.00$ ).

When we look at the scores for grit, we can see there was no significant difference in the score for completed (M=3.64, SD=0.58) and incomplete (M=3.62, SD=0.55) conditions;  $t(.331)$ ,  $p=0.741$ ).

**H<sub>7</sub>** There should be significant correlation between grit and conscientiousness measures as they measure similar personality traits and attributes.

To examine the correlation between the scores, a Pearson's product-moment correlation coefficient was calculated to assess the relationship between the grit score of participants and the conscientiousness score of participants. There was a correlation between the grit and conscientiousness [ $r = 0.579$ ,  $n=316$ ,  $p= 0.000$ ].

As we had seen before that there was not a correlation between grit and the complete and incomplete versions of the survey, a Pearson's product-moment correlation coefficient was calculated to assess the four possible conditions:

Table 3.6 *Correlation Table between conscientiousness and grit across different scenarios.*

	Correlation
Complete, unsolvable first	.700
Complete, unsolvable middle	.711
Incomplete, unsolvable first	.518
Incomplete, unsolvable middle	.094

It can be seen that for three of the four groups, there is a significant relationship between grit and correlation except for the final group, where the relationship is very weak and not significant.

## 4.0 Discussion

### 4.1 Discussion of results

The purpose of this study was to measure the effects of grit, conscientiousness and task order on the performance over a series of problems containing unsolvable problems. It was also an attempt to effect of the position of the unsolvable problems in the series of problems and to measure if there was a significant difference in completion rates depending on the type of start people had in the data. There was also an attempt to see if the cognitive theory of learned helplessness or the classic theory was more applicable to this type of situation.

In doing this, there was an attempt to see if people who were involved in repetitive tasks that were cognitively challenging were affected by uncontrollable failure. In certain jobs where the likelihood of success is uncertain, the goal was to reveal if people are more likely to perform poorly or well depending on the start that they have. It should also show the affect the positioning of the tasks could have on their likelihood to complete the remainder of the task and how work they will work on the remainder of the task. There should also be guidance as to whether grit and conscientiousness make good predictors of completing the task and the effort and accuracy after unsolvable problems.

There was possible support for the work of Ric & Scharnitzky (2003) in relation to the number of questions need to induce the performance reduction, as the study was unable to replicate the work of Horatio and Seligman (1975) or Mikulincer (1989) in causing accuracy reduction using just three questions. Ric & Scharnitzky (2003) found that they needed six or eight to reach this performance reduction and the results of this study would point to a number above three. However, there was no effect on performance in the questions on subsequent questions which would mean that either the effect is not as strong as mentioned in other research or that insufficient unsolvable problems were used here to cause a decrease in performance.

In looking at the task order effect findings from the study, two distinct areas must be examined. Firstly, as noted in the results section, there was no significant effect in having the unsolvable part first or in the middle. The average times and accuracy were not significantly different and this would seem to indicate that the task order is not important in situations of unsolvable problems and solving subsequent problems. Secondly, Monsell (2003) there is area of switching costs between tasks. Monsell (2003) looks at the cost of moving from one type of task to another and in this study we eliminated this by keeping the tasks the same. This could point to the fact that some of the effects seen in the other studies mentioned could be down to the switching costs that Monsell (2003) mentions, especially where the switch is to a more difficult task.

In the experiment, grit did not have a significant correlation with the level of performance or effort expended on questions post unsolvable question. It was also not shown to be a predictor of completion of the test. The research that had looked at grit up to now had looked at long term goals, and Duckworth and Quinn (2009) had raised queries on how likely grit was to be a predictor of short term task performance. There does not appear to be a strong predictive basis for short-term tasks, so this research would recommend that the Grit-S scale be used exclusively for longer-term goals and not for tasks or unsolvable problems, in accordance with the literature.

In looking at conscientiousness as a measure, it can be seen that it was not significant in when comparing the how quickly and accurately people answered the questions post the unsolvable problems. Therefore, it seems that there is not a relationship between conscientiousness and performance on a task. There was a significant correlation between the trait conscientiousness and the likelihood that a participant would complete the test once they had started, more or less regardless of the order of the subsequent questions. It can be seen this would appear to bear out the research of Minbashian et al. (2010), who saw that there is a correlation between task conscientiousness and the trait conscientiousness. The results would

also appear to show that conscientiousness could possibly be an indicator variable for those who are more likely to overcome situations that could induce learned helplessness or at the very least that they are less likely to be affected by setback or other issues. Minbashian et al. (2010) did not include a qualitative measure of the standard of performance on tasks and if that standard was related to conscientiousness. It would appear from this study that it is more limited to completion rather than level of performance.

In relation to the application of this work, it would suggest that conscientiousness is a good predictor of how dedicated people will be to the completion of tasks that are repetitive and have a chance of failure but will not server as a guide to effort expended or performance.

Grit and conscientiousness on this survey were correlated positively at a moderate level, which would seem to bear out the work of Roberts et al. (2012) in the introduction that saw that they shared some of the same core facet. It would make sense for the two items to be correlated but from the other results, we can see that the grit is more suitable for long-term goals (Duckworth & Quinn, 2009). The results would seem to bear out the doubts that they expressed on task completion.

With relation to the theories of learned helplessness, when we look at the predictions of Mikulincer (1989) and those of Abrahamson, Seligman and Teasdale (1978), we can see that there is no conclusive answer to this question. Neither theory can be validated, as the expected performance decrease does not appear. In addition, the level of time spent on each question would appear to support the cognitive theory first and then the classical helplessness, in that it increases on question two and then decreases on the third question but without additional questions, it is impossible to get a conclusive measure of this.

In this study, there has not been any support for the research of Horatio & Seligman (1975) or Ric & Scharnitzky, (2003) in relation to the effects of the unsolvable problems

affecting subsequent performance on problems. In relation specifically to the work of Ric & Scharnitzky (2003), there was no evidence that the effort expended changed depending on the where the questions were situated either pre or post unsolvable questions. In addition, the specific focus questions, four and five had similar levels of accuracy and time no matter where they were located in the quiz. The same was also true on questions six, seven and eight.

In relation to cognitive theory as stated by Mikulincer (1994), the informational investment in the questions should increase over the questions but in fact, the opposite is true as less time is invested on average in the third unsolvable questions (for details, see appendix 9). These theory would have also predicted cognitive exhaustion at this stage but this also appear not to have taken place as the subsequent performance is much faster than the earlier ones and the accuracy levels are high (see appendix 10 for both tables).

## **4.2 Limitations of the study**

There were a number of limitations to the study, which I will summarize in two groups—the first are foreseen issues, which could not be helped, and the second were limitations that became more apparent as the study progressed.

This study was carried out online, which allowed participants to drop out much more easily and to be distracted by their day-to-day tasks or other distractions online while completing the survey. It boosted the ecological validity, in that the setting for users was more natural than sitting in a laboratory but this also allowed for other variables such as other distractions to interrupt people while they were performing the test portion. In general, the results show that there seems to have been little difference in the mean across the different groups and the SD was relatively low in most of the results in the questions being studied. If the research was being repeated by other researchers, there could be a possible benefit in using a laboratory based

setting for a sample, so they could be compared with the online version to establish if there was a significant difference.

Related to the online nature of the exam, there was no way to answer people's questions as they arose on the test in case they were unsure how to proceed or on any queries they had. Four hundred and seven people went to the start page of the survey and clicked through but over eighty dropped out before they had inputted any detail beyond the first page. There is no way of telling if these people resolved to go back later and anecdotal evidence would suggest that this did occur but later drop out due to uncertainty on how to proceed did occur, in spite of explicit instructions. Given the results that there was a significant difference in conscientiousness between completers and partial completers, then it could be speculated that a great completion rate from the eighty-one who left earlier may have had an effect in strengthening this effect. As there was no significance between completers and partial completers in performance, it is impossible to know if group of 81 dropouts would have had an effect on the final results for effort expended (time) or accuracy.

Ric & Scharnitzky (2003) stated there was only a sizeable effect on performance when over six questions were used, so there was always a risk that three unsolvable problems would be insufficient to produce the difference in performance compared to their work. However, including six or 8 unsolvable problems would have made the test portion of the work at least 10 or 12 questions long and there was a risk that this number of unsolvable problems would cause people to quit over a perceived error in the system or through frustration in a non-laboratory setting. Additionally, a number of other researchers cited above achieved the result with three unsolvable problems, so it is believed that the trade of usability of the study had to be balanced with a number that had been proven to show a significant result before.



There were some issues that occurred in the experiment that were not anticipated and that may have had an effect on the results. In measuring the responses between the two conditions, there was no significant difference on task order. In the survey as a baseline, it would have been useful to include a baseline group who received no impossible questions so it could be tested what affect, if any these questions were having. Judging by the response on questions six, seven and eight, there does not appear to be a significant effect but without a complete group, it is impossible to know how big the performance change, if any, caused by the unsolvable problems is. As this test was concerned with task order, this would have required two additional branches with the A/B question orders repeated but with only solvable questions in each. This would have been a relatively easy change to make but due to the uncertainty in how many participants would take part, it would also cause there to be a risk that each of the four groups would be too small for meaningful analysis. The large numbers of respondents and the speed with which the data was collected was quicker and larger than expected so there was not sufficient time to gather this additional information. However, the time taken on average was less than I would have expected, so this could have been an option on this.

The personality variables that were chosen in the paper provided a good balance of one variable, conscientiousness, that had significant evidence that it was a good predictor of task perseverance and a trait that has been defined more recently, grit, which had less evidence that it was suitable for this type of predictive value. As the results showed, the evidence on conscientiousness (Gellatly, 1996, Barrick et al., 2001, Minbashian et al., 2010) and grit (Duckworth & Quinn, 2009, Duckworth et al., 2007) were correct. As the tests for both were relatively short at nine and eight item scales respectively, it would have been possible to add an additional measure on the test to see if there were other predictor variables that could be used in this situation. Research before had looked at locus of control and attribution style and these

would have been suitable to include as a comparison. The mean time was just over five minutes for the test, so an additional page would probably have been feasible to include.

In addition, there was also an opportunity to include a measure of self-efficacy testing before and after the test to see how stable self-efficacy scores after dealing with unsolvable problems and to verify if research that cited it was a reliable guide to completion (Youngju, 2013). Self-efficacy scores are generally seen as a stable variable (Miyoshi, 2013) but the survey would have allowed us to measure the effects of unsolvable problems on these. In addition, Miyoshi (2013) also states that generalized self-efficacy is more stable than task-based self-efficacy, so there may be greater effect than was expected.

One of the practical difficulties with a test of this type is deciding the correct types of questions to ask. Working with pictorial problems would be the best, as it would remove any issues around comprehension and be accessible to native speakers of any language. The issues around this were mainly technical, as finding a group of visual pattern problems was not possible, and there would have been technical difficulties in creating a quiz using them as the questions. Mathematical pattern questions were the next option, as they do not have any language bias, are easier to create, and could be manipulated more easily. The limitation here is that there are people who have anxiety in relation to mathematical problems which could potentially bias them against attempting the test, although most research in this area has concentrated on school children and undergraduates (Chinn, 2008). The final option was to use verbal puzzles or word games but this would have made the survey less accessible to non-English speakers. It must also be noted that anyone with dyslexia or language comprehension issues would have issues with a verbal test. The decision to use mathematical problems was a balance between having a universally understood test and having one that could be easily set up and done online. As the research dealt with unsolvable problems, it was felt that the additional difficulty that some people find with mathematical would be required for the debriefing to be very clear but it would also

make it more likely that there would be a clear difference in performance unsolvable problems. Chinn (2008) also specifically mentioned Seligman (1998) saying in his book *Learned Optimism* that doing Mathematical problems quickly is one of the ways to induce learned helplessness.

The sample size of the survey was sufficient to meet all the statistical analysis that I wished to carry out on the data (Cohen, 1992) but as the sample was a convenience sample of Facebook, Twitter and LinkedIn users as well as the authors friends and colleagues, it may be difficult to estimate the representativeness of the overall sample. As such, they are likely to share the same background as the author and as the sample was international, it is difficult to measure it in an Irish or European context. As the test was carried out online, anyone who did not have an internet connection was excluded and those who did not speak English at a reasonable level would have struggled to complete the test. In mitigation, online posting did allow a larger sample than would have been possible with a specific group or a laboratory based experiment. In particular, posting publically on Twitter and LinkedIn (see appendix 5) allowed a wider sample to be gathered outside the convenience sample.

Finally, having a button on each question that would allow people to go straight to the end might have eliminated the motivation to race through the questions without pausing to work them out and would mirror real life where people can quit much more easily. This would make it easier to see how many people would give up, if given a chance on more difficult or impossible questions.

#### **4.3 Recommendations for further research**

The results of the experiment, while inconclusive in many instances, do leave a large number of questions in need of a more exact answer or yet to be explored. These can be split into

three groups; those that focus on the unsolvable problems; those that look at the task order of the problem; and those that look at the area of switching costs between different types of activities.

In terms of the unsolvable problems, there is still a gap in research on how many unsolvable questions are required to cause even the most conscientious and resilient subject to quit or suffer side effects. This area has practical applications for teach people how to deal with seemingly impossible or difficult situations in work and exam situations and there is a lack of work in this area post Ric and Scharnitzky (2003) work. In correspondence with François Ric (personal communication, 17<sup>th</sup> March, 2013), he mentioned that they had not followed up on this research and that he was unaware of any new research in this area since then, except for a number of yet to be finished PhDs by students who had contacted him. This could be achieved by an amended version of the test used above and it would allow the researchers to gain more insight into the question.

This work would also allow a more definite answers on the reasons for the learned helplessness to occur, as it would allow more thorough testing of the classical theory of learned helplessness against the cognitive theories. There is also an opportunity to include motivation control theories, locus of control and egotism measures into the test, perhaps with the elimination of the personality traits portion. This would allow a more definitive answer to be reached in this area among the different theories.

From the results above, there does not appear to be evidence of a task order effect when dealing with performance changes post-unsolvable problems. There are a number of possible changes such as the number of problems, difficulty level and order. This research looked at a tiny selection of possible sequences but there are more practical and real world scenarios where failures are not consecutive and this could be incorporated into fresh research

This is also a gap on the effect of task switching on performance, as demonstrated by Monsell (2003), which may have been a factor in previous research. A comparison of performance and effort post unsolvable problems could allow researchers to measure how much of the subsequent poor performance is down to a switching cost and how much to the problems. This could also shed new light on previous studies of learned helplessness, as they all seem to employ a two-task set up.

There would be potential to run this in an applied setting where people who deal with problem pattern like this, such as students or sales people, are tested as a discrete group in comparison to a wider sample, to see if they have developed better coping and performance strategies or if these are uniform across populations.

In summary of the overall experiment, we can see that the research did not agree with a number of the findings of Ric and Scharnitzky (2003) and Mikulincer (1990) on the effect of unsolvable problems and it proved impossible to show any significant difference in task order on effort or performance on subsequent tasks. There was no definite answer on the number of questions needed to cause learned helplessness in a survey but the results seem to suggest more questions would probably be necessary in line with their research (Ric & Scharnitzky, 2003). There was a difference between those who failed to complete the exam and those who did based on conscientiousness score but there was no correlation with the Grit-S scale on whether the test was completed.

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## Appendices

### Appendix 1

#### *Occupation of Sample*

Position of unsolvable questions			Frequency	Per cent	Valid Per cent	Cumulative Per cent
First	Valid	Accounting / Finance	12	7.5	7.5	7.5
		Administration / Cle	8	5.0	5.0	12.5
		Advertisement / PR	1	.6	.6	13.1
		Architecture / Design	4	2.5	2.5	15.6
		Buying / Purchasing	1	.6	.6	16.3
		Construction	1	.6	.6	16.9
		Consulting	2	1.3	1.3	18.1
		Customer Service	5	3.1	3.1	21.3
		Education	15	9.4	9.4	30.6
		Health Care (Physical	13	8.1	8.1	38.8
		Human resources	1	.6	.6	39.4
		mana				
		Management (Senior /	8	5.0	5.0	44.4
		N/A - Unemployed /	7	4.4	4.4	48.8
		R				
		News / Information	4	2.5	2.5	51.3
		Operations / Logistics	2	1.3	1.3	52.5
		Other	21	13.1	13.1	65.6
		Production	1	.6	.6	66.3
		Real Estate	1	.6	.6	66.9
		Research	3	1.9	1.9	68.8
Restaurant / Food se	1	.6	.6	69.4		
Sales / Marketing	18	11.3	11.3	80.6		
Science / Technology	19	11.9	11.9	92.5		
Social service	7	4.4	4.4	96.9		
Student	5	3.1	3.1	100.0		
Total		160	100.0	100.0		
Second	Valid	Accounting / Finance	15	9.6	9.6	9.6
		Administration / Cle	9	5.8	5.8	15.4
		Advertisement / PR	2	1.3	1.3	16.7
		Architecture / Design	3	1.9	1.9	18.6
		Arts/Leisure / Enter	3	1.9	1.9	20.5
		Beauty / Fashion	1	.6	.6	21.2
		Construction	3	1.9	1.9	23.1
		Consulting	2	1.3	1.3	24.4
		Customer Service	1	.6	.6	25.0
		Distribution	1	.6	.6	25.6

Education	19	12.2	12.2	37.8
Health Care (Physical	6	3.8	3.8	41.7
Human resources management	8	5.1	5.1	46.8
Management (Senior /	7	4.5	4.5	51.3
N/A - Unemployed / R	3	1.9	1.9	53.2
News / Information	4	2.6	2.6	55.8
Operations / Logistics	6	3.8	3.8	59.6
Other	8	5.1	5.1	64.7
Production	1	.6	.6	65.4
Research	3	1.9	1.9	67.3
Sales / Marketing	23	14.7	14.7	82.1
Science / Technology	16	10.3	10.3	92.3
Social service	2	1.3	1.3	93.6
Student	10	6.4	6.4	100.0
Total	156	100.0	100.0	

## Appendix 1.1

*Country of residence of sample*

Position of unsolvable questions		Frequency	Per cent	Valid Per cent	Cumulative Per cent	
First	Valid	Australia	9	5.6	5.6	5.6
		Canada	8	5.0	5.0	10.6
		Germany	2	1.3	1.3	11.9
		India	1	.6	.6	12.5
		Ireland	110	68.8	68.8	81.3
		Japan	1	.6	.6	81.9
		Netherlands	1	.6	.6	82.5
		New Zealand	1	.6	.6	83.1
		Slovakia	1	.6	.6	83.8
		Spain	2	1.3	1.3	85.0
		Sweden	1	.6	.6	85.6
		Switzerland	1	.6	.6	86.3
		United Kingdom	19	11.9	11.9	98.1
		United States	3	1.9	1.9	100.0
		Total	160	100.0	100.0	
Second	Valid	Australia	5	3.2	3.2	3.2
		Canada	1	.6	.6	3.8
		Croatia	1	.6	.6	4.5
		France	3	1.9	1.9	6.4
		Germany	1	.6	.6	7.1
		India	3	1.9	1.9	9.0
		Ireland	117	75.0	75.0	84.0
		Morocco	1	.6	.6	84.6
		Netherlands	1	.6	.6	85.3
		Slovakia	1	.6	.6	85.9
		South Africa	1	.6	.6	86.5
		United Kingdom	17	10.9	10.9	97.4
		United States	4	2.6	2.6	100.0
		Total	156	100.0	100.0	

## Appendix 2

### Problem Solving Test

#### Introduction

My name is Peter Lowney and I am conducting research as part of my Higher Diploma in Psychology at Dublin Business School. In my research I am looking at the relationship between perseverance and conscientiousness and problem solving skills.

The survey includes two multiple choice questionnaires and a short test with 8 questions and all these must be completed. The survey should take under 8 minutes to complete.

Participation is completely voluntary and so you are not obliged to take part. Participation is anonymous and confidential and responses cannot be attributed to any one participant. For this reason, it will not be possible to withdraw from participation after the questionnaire has been submitted.

It is important that you understand that by completing and submitting the survey that you are consenting to participate in this study.

Should you require any further information about the research or if you would like me to provide you with the overall results of my findings please contact me at:

If you wish to contact my supervisor, please email:

The responses will be securely stored on a password protected computer. Thank you for taking the time to complete this survey.

Next

0%

## Appendix 3

**Problem Solving Test**  
Demographic Details

1. Please select your gender \*

Male

Female

---

2. Can you enter your age? (Please use digits:27, 59 etc) \*

  

---

3. Please select your occupation. \*

 ▾

---

4. Please select your country of residence \*

 ▾

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3%

## Appendix 4

### Big Five Index

#### I am someone who...

1. \_\_\_\_\_ Is talkative
2. \_\_\_\_\_ Tends to find fault with others
3. \_\_\_\_\_ Does a thorough job
4. \_\_\_\_\_ Is depressed, blue
5. \_\_\_\_\_ Is original, comes up with new ideas
6. \_\_\_\_\_ Is reserved
7. \_\_\_\_\_ Is helpful and unselfish with others
8. \_\_\_\_\_ Can be somewhat careless
9. \_\_\_\_\_ Is relaxed, handles stress well.
10. \_\_\_\_\_ Is curious about many different things
11. \_\_\_\_\_ Is full of energy
12. \_\_\_\_\_ Starts quarrels with others
13. \_\_\_\_\_ Is a reliable worker
14. \_\_\_\_\_ Can be tense
15. \_\_\_\_\_ Is ingenious, a deep thinker
16. \_\_\_\_\_ Generates a lot of enthusiasm
17. \_\_\_\_\_ Has a forgiving nature
18. \_\_\_\_\_ Tends to be disorganized
19. \_\_\_\_\_ Worries a lot
20. \_\_\_\_\_ Has an active imagination
21. \_\_\_\_\_ Tends to be quiet
22. \_\_\_\_\_ Is generally trusting
23. \_\_\_\_\_ Tends to be lazy
24. \_\_\_\_\_ Is emotionally stable, not easily upset
25. \_\_\_\_\_ Is inventive
26. \_\_\_\_\_ Has an assertive personality
27. \_\_\_\_\_ Can be cold and aloof
28. \_\_\_\_\_ Perseveres until the task is finished
29. \_\_\_\_\_ Can be moody
30. \_\_\_\_\_ Values artistic, aesthetic experiences
31. \_\_\_\_\_ Is sometimes shy, inhibited

32. \_\_\_\_\_ Is considerate and kind to almost everyone
33. \_\_\_\_\_ Does things efficiently
34. \_\_\_\_\_ Remains calm in tense situations
35. \_\_\_\_\_ Prefers work that is routine
36. \_\_\_\_\_ Is outgoing, sociable
37. \_\_\_\_\_ Is sometimes rude to others
38. \_\_\_\_\_ Makes plans and follows through with them
39. \_\_\_\_\_ Gets nervous easily
40. \_\_\_\_\_ Likes to reflect, play with ideas
41. \_\_\_\_\_ Has few artistic interests
42. \_\_\_\_\_ Likes to cooperate with others
43. \_\_\_\_\_ Is easily distracted
44. \_\_\_\_\_ Is sophisticated in art, music, or literature

## Appendix 5

### Short Grit Scale

#### Short Grit Scale

*Directions for taking the Grit Scale: Please respond to the following 8 items. Be honest – there are no right or wrong answers!*

1. New ideas and projects sometimes distract me from previous ones.\*
  - Very much like me
  - Mostly like me
  - Somewhat like me
  - Not much like me
  - Not like me at all
  
2. Setbacks don't discourage me.
  - Very much like me
  - Mostly like me
  - Somewhat like me
  - Not much like me
  - Not like me at all
  
3. I have been obsessed with a certain idea or project for a short time but later lost interest.\*
  - Very much like me
  - Mostly like me
  - Somewhat like me
  - Not much like me
  - Not like me at all
  
4. I am a hard worker.
  - Very much like me
  - Mostly like me
  - Somewhat like me
  - Not much like me
  - Not like me at all
  
5. I often set a goal but later choose to pursue a different one.\*
  - Very much like me
  - Mostly like me
  - Somewhat like me
  - Not much like me
  - Not like me at all
  
6. I have difficulty maintaining my focus on projects that take more than a few months to complete.\*
  - Very much like me
  - Mostly like me
  - Somewhat like me
  - Not much like me
  - Not like me at all
  

---

  
7. I finish whatever I begin.
  - Very much like me
  - Mostly like me
  - Somewhat like me
  - Not much like me
  - Not like me at all
  
8. I am diligent.
  - Very much like me
  - Mostly like me
  - Somewhat like me
  - Not much like me
  - Not like me at all



**Scoring:**

1. For questions 2, 4, 7 and 8 assign the following points:
  - 5 = Very much like me
  - 4 = Mostly like me
  - 3 = Somewhat like me
  - 2 = Not much like me
  - 1 = Not like me at all
  
2. For questions 1, 3, 5 and 6 assign the following points:
  - 1 = Very much like me
  - 2 = Mostly like me
  - 3 = Somewhat like me
  - 4 = Not much like me
  - 5 = Not like me at all

Add up all the points and divide by 8. The maximum score on this scale is 5 (extremely gritty), and the lowest score on this scale is 1 (not at all gritty).

**Appendix 6**

*Grouping of the questions with questions and answer.*

Group 1 Question	Group 2 Question	Questions and answers for the test
1	4	Which number should come next in this series? 4, 8, 16, 33, * 67 / 22 / 38 / 39 (unsolvable)
2	5	Which number should come next in this series? 7, 8, 12, 21, 35, * 44 / 39 / 48 / 52 (unsolvable)
3	6	Which number should come next in this series? 3, 5, 8, 13, 21, * 4 / 22 / 31 / 36 (unsolvable)
4	7	Which number should come next in this series? 1, 3, 6, 10, 15, * 8 / 18 / <b>21</b> / 23
5	8	Which number should come next in this series? 25, 24, 22, 19, 15 * 4 / 5 / <b>10</b> / 14
6	1	Which word does not belong? apple, marmalade, orange, cherry, grape Apple / <b>marmalade</b> / orange / cherry / grape
7	2	Which number does not belong in this group? 4 32 14 17 28 4 / 32 / 14 / <b>17</b> / 28
8	3	Which number should come next in this series? 3, 5, 8, 12, 17, * 4 / <b>23</b> / 31 / 34

- \* Denotes a mandatory question

## Appendix 7

### Text of the Problem instructions

On the following pages, there will be a series of eight sequencing problems.

They will involve completing the pattern of numbers like the following:

4, 5, 7, 10, 14, 19,

a. 23

b. 25

c. 27

d. 28

The correct answer is b. 25, the numbers are rising by a number that increases by 1 each time (+1, +2, +3, +4, etc.).

Answers will be timed, so please complete the answers as quickly as possible.

## Appendix 8

### Debriefing page

Thank you for taking the time to complete the survey and test.

This test was designed to measure performance after attempting to solve unsolvable problems and to study this, some of the problems in this test had no possible solution.

For this reason, there is no final score as the goal was to measure performance on these questions. If you have friends who are planning to take part, please do not share this information with them as it will affect the final results.

If any of the questions raised difficult feelings for you, I'd like to refer you to the contact number for the Samaritans who run a helpline 24 hours a day, 365 days a year: 1850 60 90 90.

If you are interested in further education courses, there is more information on <http://www.qualifax.ie/> and <http://www.aontas.com/>

Thanks again for taking part and if you have any questions, please email on [1653060@mydbs.ie](mailto:1653060@mydbs.ie)

## Appendix 9

*Mean time required for each question*

	N	Mean	Std. Deviation
Timer1	300	47.8867	75.94361
Timer2	287	87.8885	128.86395
Timer3	270	81.1778	349.73941
Valid N (listwise)	270		

## Appendix 10

*Mean time per question depending on position of the unsolvable problems*

Position of unsolvable questions		N	Mean	Std. Deviation
First (Branch A)	Timer1	154	45.1818	60.75801
	Timer2	144	82.3958	111.39153
	Timer3	134	99.1866	477.68752
	Timer4	123	24.3740	30.60440
	Timer5	122	20.6230	25.67995
	Timer6	121	13.3306	8.75251
	Timer7	121	33.8347	154.97690
	Timer8	121	19.6612	16.96592
	Valid N (listwise)	121		
Second (Branch B)	Timer1	146	50.7397	89.34019
	Timer2	143	93.4196	144.52981
	Timer3	136	63.4338	135.22320
	Timer4	131	21.4198	14.85828
	Timer5	127	16.7402	7.20032
	Timer6	127	11.3071	6.82725
	Timer7	127	19.4646	29.02046
	Timer8	127	18.9843	15.98361
	Valid N (listwise)	127		

*Average score out of 100 on questions 4-8*

Position of unsolvable questions		N	Mean	Std. Deviation
First	Answer4	123	93.4959	24.76062
	Answer5	122	95.9016	19.90698
	Answer6	121	97.5207	15.61415
	Answer7	121	85.9504	34.89457
	Answer8	121	94.2149	23.44327
	Valid N (listwise)	121		
Second	Answer4	130	91.5385	27.93851
	Answer5	127	96.8504	17.53458
	Answer6	127	94.4882	22.91145
	Answer7	127	91.3386	28.23828
	Answer8	127	98.4252	12.49922
	Valid N (listwise)	127		

## **Appendix 11**

*Examples of Social media use to wide survey sample.*

***LinkedIn***

***Twitter***