Novel Behavioral Measure of Specific and Diversive Curiosity and its Correlation to Academic

Performance, Religiousness, and Political Interest and Affiliation

Kelilani D. Johnson

University of Colorado, Boulder

Honors Committee:

Matthew Jones, PhD – Thesis Advisor

Alice Healy, PhD – Psychology Department

Michael Saddoris, PhD – Psychology Honors Council

Michael Haffey, PhD – Sociology Department

4 November 2016

Key Terms: curiosity, perceptual curiosity (PC), epistemic curiosity (EC), diversive curiosity (DC), specific curiosity (SC), and total curiosity (TC).

Abstract

Approximately 220 college-aged participants were given a novel behavioral measure of curiosity (Johnson-White Scale) in order to obtain participants' total epistemic curiosity scores, diversive curiosity scores, and specific curiosity scores. The task consists of a white computer screen with 25 icons ranging from topics of culinary arts (as represented by an up-scale plate of food) to rock climbing to video games. There are a total of 175 facts available for discovery through the clicking of the icons. After eight minutes to interact with the Johnson-White Scale (JWS), participants receive a personal survey of factors including but not limited to: ACT score, political interest, political affiliation, and religiousness. Participants then took two separate self-report measures of curiosity, the Novelty Experiencing Scale (Pearson, 1970) and the Melbourne Curiosity Inventory Trait-Form (Naylor, 1981) in order to understand whether the Johnson-White Scale yields a valid measure of curiosity. Various personal factors were gathered to illuminate whether curiosity and subtypes of curiosity are predictive of certain life outcomes such as academic success and political and religious involvement. Potential for the validity of the Johnson-White Scale is present as portrayed by correlations between the self-report measures' scores and the interactive behavioral measure's scores, as they tended to correlate significantly well in most facets and sub-facets of curiosity. Furthermore, levels of curiosity may be predictive of certain personal factors, especially academic performance.

Models of Curiosity: Specific, Diversive, Epistemic, and Perceptual

Curiosity has been analyzed and studied a handful of times in previous research with different models. Defined by Litman and Spielberger as: "a desire for acquiring new knowledge and new sensory experience that motivates exploratory behavior" (Berlyne, 1949, 1950, 1954, 1960; Loewenstein, 1994; Spielberger & Starr, 1994; Litman & Spielberger, 2003), curiosity is seen to be the motivation for which individuals engage in exploratory behavior as opposed to being the behavior itself (Spielberger & Starr, 1994). The motivation, curiosity, has many facets that have been analyzed and studied by numerous researchers. Berlyne (1954) identified what he found to be two types of curiosity called perceptual and epistemic curiosity (PC and EC). PC was brought about in individuals by physical stimuli that appealed to the physical senses such as visual, auditory, and tactile (Berlyne 1954; Litman & Spielberger 2003). The other type of curiosity identified by Berlyne, EC, was identified as the intrinsic drive to know. This would relate to an individual's desire to understand a problem or solve a riddle. The equivalent to EC in Pearson's model (1970) is the combination of the two types of curiosity: Internal and External Cognition, dealing with all "drive to know" components of curiosity. Pearson suggested there were in turn four types of curiosity: External Sensation, Internal Sensation, External Cognition, and Internal Cognition.

Berlyne's (1960) model places specific and diversive exploration as key sub-facets in the analysis and measurement of epistemic and perceptual curiosity. Diversive curiosity is a general condition considered as the need to seek new experiences or extend one's knowledge into the unknown. Day (1971) called diversive exploration the "breadth of knowledge". Specific curiosity is defined as the aroused state of an organism when confronted by an ambiguous stimulus that may result in specific exploration (Day 1968), referred to as the "depth of

knowledge." This paper will focus on the specific and diversive components of curiosity (Litman & Spielberger, 2003; Spielberger & Starr, 1994) as individual facets under epistemic curiosity, and how both SC and DC (as analyzed by a novel behavior measure) correlate with aspects such as: college GPA, ACT scores, political interest and affiliation, and religiousness. Furthermore, the behavioral measure's curiosity scores will be compared to established measures to understand the validity of the novel measure—called the Johnson-White Scale—in measuring an individual's levels of total, diversive, and specific curiosity.

Self-Report Measures of Curiosity

The most common form of measuring curiosity is with self-report surveys and questionnaires from which a total curiosity score for an individual can be measured and quantified. With these self-report measures, different facets of curiosity can also be quantified, depending on the model. Litman & Spielberger (2003) looking to compare curiosity measurements, mention numerous different measurements and use four of them in their study: The Curiosity Questionnaire (Collins, 1996), The State–Trait Personality Inventory (STPI; Spielberger et al., 1979), The Novel Experiencing Scale (NES; Pearson, 1970), and the SSS Thrill-and-Adventure and Experience Seeking subscales (Litman & Spielberger, 2003). Litman & Spielberger state that all the scales mentioned in their research share a commonality in that they: "assess tendencies to engage in exploratory behavior," (p. 76); however, they rely on the accuracy of the answers provided by the individual. Creating a behavioral measure of curiosity can work to obtain a more objective measure and objective understanding of an individual's tendency toward exploratory behavior for the sake of obtaining new knowledge.

In this study, the Johnson-White Scale—a novel behavioral measure of curiosity that takes the form of an educational task—was developed to measure levels of SC and DC under the epistemic curiosity (EC) branch, as well as a measure of total curiosity (sum of SC and DC). The results from the Johnson-White Scale will be compared to the subject's scores and ranking on two alternate curiosity self-report measures: The Novelty Experiencing Scale (NES; Pearson, 1970) and the Melbourne Trait Inventory Scale (Naylor, 1981).

The NES is a self-report survey consisting of 80 items where participants must choose whether they "like" or "dislike" a given item. Items are presented in the form of statements and include a wide range of activities such as: "Losing [my]self in daydreams," "Reading the world Almanac," or "Going on a safari" (Pearson, 1970). Out of the 80 items on the NES, 20 fit in each of Pearson's four theorized categories of exploration and curiosity. Those are as previously mentioned: External Sensation, Internal Sensation, External Cognition, and Internal Cognition. External Sensation relates to the desire to seek out physically arousing stimuli such as "exploring the ruins of an old city in Mexico…" (Pearson, 1970). This facet relates to Berlyne's PC, but for the purposes of this paper, external sensation is not a focus of the Johnson-White Scale. Internal Sensation is defined by Pearson (1970) as: "a tendency to like (vs. tendency to dislike)the experience of unusual dreams, fantasy, or feelings which are internally generated," (p. 201). The decision to include Internal Sensation in the NES for this particular study was made based off the definition's similarity to EC in the desire to know what is unknown regardless of whether it is internally or externally driven. External Cognition encompasses mental activities that exist in the physical world such as: "learning new facts about WWII" (Pearson, 1970), whereas Internal Cognition entails the metaphysical desire to know, such as the complex inner-workings of a system, an example provided by Pearson being: "Thinking about why people behave the way

they do," (p. 200). In each type of curiosity, there are specific and diversive components.

However, in this study the emphasis is not on analyzing and comparing the data with all of the four measures separately, but using the total curiosity score calculated from the number of "likes" given out of the 60 items to correlate with the overall curiosity score quantified using the novel Johnson-White Scale for SC, DC, and total curiosity (TC). The NES will be used for its high correlations with other reputable curiosity measurements (Pearson, 2003) and ability to quantify total curiosity across facets.

The Melbourne Curiosity Inventory-Trait Form (MCI) is a survey in which the participants read a statement and select whether or not they disagree on a scale from 1-4, 1 being "least like" the subject and 4 being "most like" the subject. In this 21-item survey, 7 of the items are used to calculate SC and 6 are used to calculate DC while the others are general curiosity questions, or fillers. The Trait Form of the inventory looks at trait curiosity and the "individual differences in the potential for curiosity experiences" (Naylor, 1981). In this study, the Trait Form which measures trait curiosity is more relevant to EC whereas state curiosity relates to Physical Thrill Seeking as a form of curiosity (exploration). Trait curiosity defined as individual differences in the ability to experience curiosity (Naylor, 1981). It reflects the propensity to respond to alternative situations with curiosity. This measurement is chosen to compare to the Johnson-White Scale due to the strong focus on particularly specific and diversive components of EC.

Throughout curiosity research, there have been various methods of measurement proposed, however nearly all have been self-report measures. A valid, objective measure of curiosity does not yet exist. Curiosity is a complex motivating trait that cannot be left to self-

report. Self-report measurements have many flaws, one being the potential for dishonesty. Whether the participant wants to embellish and portray a desired image for him or herself to the researcher, or whether the participants gives into demand characteristics altering their answers in attempts to achieve some perceived expectation, results from self-report measures are not always accurate. The formulation of a valid, objective measure of curiosity can greatly contribute to understanding subconscious motivations that may exist within an individual that may otherwise not be obtained through self-report, subjective measures. By applying the objective and self-report measures to one another, potential validity of the objective measure—in this case the Johnson-White Scale—can be evaluated. From there, the examination of personal life outcomes such as academic success, political interest and affiliation, and religiousness and their relation to curiosity can potentially show the importance of inspiring and fostering EC in children from a young age. If curiosity as a motivating force can be better understood and tapped into, it could increase the pursuit of academics.

Experiment

In this study, participants were run through the Johnson-White Scale to assess curiosity levels as gathered from a behavioral, task-oriented measure. Survey data on personal factors of interest were also collected in order for the relationship between curiosity and life outcomes such as: academic performance, religiousness, and political interest and affiliation, to be examined. Furthermore, the Johnson-White Scale's validity in measuring EC and its sub-facets DC and SC was evaluated through the comparison of curiosity scores from the Johnson-White Scale to the curiosity scores assessed using established self-report measures. The rationale behind the creation of an interactive curiosity measure is to allow the participant's own curiosity to motivate him or her to interact with the program as interacting is neither forced nor required. Having full

control of the interactive experience facilitates the participant's inherent curiosity, allowing the participant to gravitate toward the stimuli that are found to be most engaging or interesting. The presence of "Back" buttons, allows for the participant to quickly leave a stimulus and select a new one in order to keep the participant's curiosity flowing for the duration of the task (8 minutes). The hypotheses in this study are as follows: (1) to explore whether epistemic curiosity (or sub-facets thereof) is predictive of certain life outcomes such as academic success and political and religious involvement, and (2) examine the results of both the established measures and the Johnson-White Scale to see whether the Johnson-White Scale is a valid measure of curiosity. A sub-goal of this study is to see whether the Johnson-White Scale can provide valid separate assessments of what might be psychologically distinct facets of curiosity (DC and SC).

Method

Participants

Data were recorded for 220 participants. Participants were students at the University of Colorado, Boulder enrolled in General Psychology participating in research for class credits.

Materials

In this study, participants responded to the Johnson-White Scale of curiosity, one electronic survey, and two preexisting curiosity measures on paper. As previously stated, one of the preexisting curiosity measures used is the NES; this measure quantifies the total curiosity (TC) score of a participant which was then correlated with the TC score quantified by the Johnson-White Scale for the same participant. The second self-report curiosity measurement the participants took is the MCI to measure SC and DC and correlated them with matching SC and DC scores from the Johnson-White Scale.

Novelty Experiencing Scale (altered). The NES used for the purposes of this study, is a self-report measure with 60 items measuring the sub-facets of curiosity according to Pearson (1970) such as: Internal Sensation, Internal Cognition, and External Cognition. Participants circle either "like" or "dislike" for each item on the survey. TC is calculated by finding the sum of "liked" items.

Melbourne Curiosity Inventory – Trait Form. The MCI is a self-report curiosity measure that consists of 20 items: 6 diversive, 7 specific. The remaining 7 items are filler statements relating to curiosity. An example of a specific item is: "I feel involved in what I do," whereas a diversive item example is: "New situations capture my attention," (Naylor, 1981). The participant must decide whether each of these statements relate to how one "generally feels" (Naylor, 1981) most of the time using a 1 – 4 scale (1 = almost never, 2 = sometimes, 3 = often, 4 = almost always). From here, DC and SC scores can be calculated separately or as part of the overall TC scores.

Johnson-White Scale. The Johnson-White Scale was the first curiosity test shown to participants. The program, which runs on Psychopy, consists of various images on a white screen as seen in Figure 1, all of which are clickable. When a participant clicks on a particular image the program gives the participant a "fun fact" about that image in which there are two more icons that appear below the fact with different questions or statements on them meant invoke curiosity in the participant. One of these prompts is a diversive question and the other is specific, as well as a "Go Back to Main Screen" option. An example from the robotics and technology topic as represented by a picture of a toy robot, opens a window when clicked that reads: "Culinary arts have been a notable and high end art form for hundreds of years usually enjoyed by the royal and the wealthy. Today food is a large part of our lives with dozens of television shows, books, and

magazines dedicated to fancy cooking." The specific option on the bottom left reads: "High end delicacies enjoyed by the wealthy," whereas the diversive option on the right reads: "Gender roles taught through television." The specific option relates to the original fun fact linked with the image, high-end cuisine; whereas on the diversive side, the topic of interest begins to stray into other areas that would spark an individual's interest or drive to expand his or her current knowledge base (diversive curiosity). When the participants click on the specific track, the initial picture from the main screen of clickable topics is still shown but is accompanied by another fact on the same topic. From here, there is one more layer in which the participant may follow choosing again between either the specific or diversive option. If the participant clicks on any of the diversive prompts, the picture changes to relate better to the topic suggested by the prompt and gives a fact related to that prompt and picture. Once the participant has gone through all three levels of a stimulus icon from the main screen, the last fact is presented with the only clickable option reading "Go Back". "Go Back" options are also available on every page, that way participants can feel free to pursue anything that interests them at any point. For a clear visual of the layers of facts in the Johnson-White Scale, see Figure 2. There are three tiers of information in the program. Tier 1, accessible from clicking on an icon from the main screen, has 25 available facts. Tier 2, accessible from clicking on either the specific or diversive prompt from Tier 1, has 50 available facts. Tier 3, accessible from clicking on either one of two diversive or two specific prompts from Tier 2, has 100 available facts. This comes to a total of 175 facts and 150 prompts. The program records each click as either diversive or specific as well as clicks to go back to main screen as "back". The program runs for eight minutes while the participants have free reign of the stimuli. Once it has timed out, the survey begins asking them their motivation for interacting with the program (boredom, intrigue, other) and gathers

information on the personal factors (GPA, ACT scores, political interest/affiliation, and religiousness) needed for further analysis.

Survey on Personal Factors. The electronic survey starts eight minutes after the participant's initial interaction with the JWS program. The survey gathers data on the participant's age, year in school, major, GPA and ACT (academic performance), level of interest in politics, political affiliation, and religiousness. For a measurement of a participant's interest and involvement with current politics, the participants see a question inquiring at what level (1-7), the participants stay involved in or show interest in current politics (1 – not at all interested/involved, 4 – average level of interest/involvement, 7 – highly interested/involved). The political affiliation and religiousness questions on the survey also use a 1 – 7 scale. For political affiliation, 1 – highly conservative, 4 – moderate, 7 – highly progressive; and for religiousness, 1 – actively not religious, 4 – may hold religious views, little church involvement, 7 – devoted to one's religion.

Procedure

Each participant was tested individually in a private room with a computer. Participants were led back to one of the rooms and given the following instruction from the researcher:

"Your study will start shortly. You will be performing a couple of paper surveys in a few minutes. Please wait here until you are directed to the workroom tables. Feel free to interact with the program loaded on the computer. All icons are clickable."

Participants were then left alone for eight minutes while the program ran, free to click or not click on any icons that sparked their curiosity. At the end of eight minutes, an electronic survey immediately started to gather the participant's information (GPA, year in school, age, major,

ACT and SAT scores, religiousness, political interest and affiliation). Then, once the survey

ended, the researcher would then open the door and invite the participant out to the desk in the

main room to take the NES (Pearson, 1970) and the MCI (Naylor, 1981). Instructions for both

surveys were printed at the top of the page and the participants were instructed by the researcher

to "read the instructions and answer as honestly as possible." Once the participants completed

the surveys, they were then given appropriate credit for their participation and a feedback form

outlining the key points and purpose of the experiment as outlined above.

Results

Overall, 34 comparisons were made between personal factors (ACT, political interest,

religiousness, etc) and both the Johnson-White Scale and established self-report measures of

curiosity. Correlation and regression analysis were used to find the existing correlation, the

significance of that correlation, and the equation for the line of best fit when looking at a scatter

plot of the personal factor versus a curiosity measure.

Survey Results on Personal Factors

As previously stated, one of the aims of this study is to examine whether curiosity levels

can be predictive of certain personal life outcomes; therefore, it is important to understand the

diversity of the sample in response to personal factors. In regards to ACT scores, 120 out of the

143 participants who provided ACT scores fell within the 21-30 range (see Table 1) with a

median of 26 and a mean of 26.29. When looking at political interest, 50.5% of participants

reported little interest and involvement within the political sphere (responses 1-3). A similar,

perhaps one-sided sample is revealed also in the responses to political affiliation and

religiousness portraying a predominantly progressive, nonreligious sample. Only 17.5% of

participants reported conservative leanings while 51.9% reported progressive leanings (the remainder claiming moderate). Religiousness results were even more split with 65.7% of participants reporting little to no religious affiliation. For every participant who responded with a 7 (highly religious), there were nearly 12 participants who responded with a 1 (no religious affiliation). This lack of diversity existing within the sample in response to personal factors and life outcomes can potentially lead to correlations that do not accurately portray existing relationships between variables. For all participant responses on personal factors, see Table 2.

Johnson-White Scale vs. Self-Report Measures

When comparing the total curiosity (TC) scores from the Johnson-White Scale with the TC scores gathered by the NES (Pearson, 1970), the correlation was 0.0601, not statistically significant with a p-value = 0.3770 as seen in Table 3. This means the curiosity scores as determined by the Johnson-White Scale of curiosity are not predicated by or able to predict the scores of curiosity on the NES. As previously stated, the NES is used due to its tendency to correlate well with other reputable self-report measures of curiosity (Pearson, 1970). This makes the lack of a statistically significant correlation problematic for the validity of the novel behavior measure unless perhaps in the inclusion of External Sensation in the NES may lead to higher correlations with the Johnson-White Scale. See Figure 3 for full distribution of NES TC scores.

The Melbourne Curiosity Inventory-Trait Form (MCI) however, much like the Johnson-White Scale, examines the trait form of curiosity defined as individual differences in the ability to experience curiosity (Naylor, 1981). The MCI provides both a measure of the sub-facets of DC and SC and a total score (TC). This is similar to the Johnson-White Scale of curiosity which provides a score for DC, SC, and TC, or overall epistemic curiosity. When comparing the facets

of EC as measured by the MCI to the Johnson-White Scale, a significant, positive correlation

exists for both SC scores at .163 (p = .016) and DC scores at .210 (p = .002). That is to say, those

who scored high in DC or SC on the MCI also tended to receive a matching score on the

Johnson-White Scale's DC and SC components. This finding represents the potential for the

Johnson-White Scale to be a valid behavioral measure of diversive and specific curiosity.

However, the total curiosity as measured by the self-report MCI and the total curiosity as

measured by the Johnson-White Scale had a nearly, but not significant positive correlation at

.1270, p = .0612. An increase in the number of subjects may allow for this correlation to become

significant, much like the correlations for both DC and SC. Both the NES and the MCI had a

highly significant positive correlation when comparing the TC scores from each with the

correlation .4611 (p = 7.08×10^{-13}), the highest correlation among the measures. For all MCI

curiosity scores, see Figure 4.

When looking at the validity of the sub-facets of curiosity DC and SC in their ability to

measure separate components, DC and SC scores as gathered by the MCI and by the Johnson-

White Scale show highly significant, positive correlations between the two sub-facets. DC and

SC from the MCI show a correlation of .626, p = 2.20×10^{-16}. The correlation between DC and

SC as measured by the Johnson-White Scale is .445, p = 5.46×10^{-12} (see Table 4). The close

correlation of the two sub-facets speaks to the similarity of the sub-facets and the similarity in

what they say about an individual's curiosity and interests. This shows the sub-facets in both the

MCI measure and the Johnson-White Scale are intimately related; however, this does not

necessarily mean they aren't measuring different components of curiosity. DC and SC are sub-

facets under the EC facet of curiosity meaning any differences between the sub-facets is overall

expected to be minimal as both contribute to EC—or TC. The similarity between DC and SC

seen in the Johnson-White Scale, and seen even more so in the established MCI, further works to present evidence for the validity of the Johnson-White Scale in being a strong potential curiosity measure that is task oriented instead of relying on the honesty and accuracy of subjective self-report. For curiosity scores of participants as measured by the JWS, see Figure 5 and Figure 6.

Personal Factors vs. Established Measures.

Academic Performance. When comparing academic performance with curiosity, GPA was an unreliable determinant due to the overwhelming number of freshmen participants (68% of all participants) who had yet to accumulate a GPA. However, last ACT scores were reported by nearly all participants allowing for correlations between ACT scores and TC, DC, and SC as measured by the MCI, and the NES total curiosity scores.

When comparing participants' last ACT scores to the MCI scores for TC, no significant correlation was found as seen in Table 5. However, the NES measure of TC has a significantly positive correlation ($r = .164$) with reported ACT scores, $p = .048$. This portrays the existence of a potential relationship between an individual's epistemic curiosity—"drive to know" (Berlyne 1954) and academic performance. This is expected as an individual who is more motivated by the attainment of knowledge (curiosity) would perform better on a standardized test designed to test an individual's academic knowledge in a number of categories (math, science, literature, etc). No significant correlations were found between the sub-facets of EC, diversive and specific curiosity, and the participant reported ACT scores with specific curiosity being nearly significant ($r = .154, p = .065$). See Table 5.

Political Interest. Seventy-five percent of participants surveyed reported between no interest/involvement to an average level of interest/involvement with only 25% of participants

reporting a higher than normal level of interest/involvement. When correlating political interest

with established measures, significant positive correlations were found in nearly all measures:

NES ($r = .252$, $p = 1.80 \times 10^{-4}$), MCI – TC ($r = .203$, $p = .014$), and MCI – SC ($r = .172$, $p = .011$).

However, the same was not found for the MCI's measure of DC which had a nearly nonexistent

negative correlation of -.030, $p = .653$. See Table 5 for all correlations between self-report

measures and personal factors of interest.

Political Affiliation. Out of the 220 participants surveyed, 83.2% reported moderate to

highly progressive political leanings with only a total of 37 participants claiming a mostly

conservative political affiliation. This is believed to greatly affect the correlations when

comparing political affiliation to curiosity scores due to the lack of conservative representation in

the sample. The only significant correlation when comparing the personal factor of political

affiliation to established, self-report curiosity measures is between the NES – TC scores and the

political affiliation of participants ($r = .162$, $p = .017$) in that those participants who tended to

report more conservative leanings tended to score lower in total curiosity. Again, with a lack of

conservative representation in the sample, the correlation may be in reality much higher or much

lower. All MCI curiosity scores showed no correlation with participants' tendency to gravitate

toward certain political affiliations.

Religiousness. As previously stated the most apparent lack of diversity within the sample

was present in religiousness responses as 65.7% of participants reported being nonreligious (1-3;

1 –no religion or spirituality), 11.1% of participants claimed a neutrality in religion and

spirituality (4), and only 23.2% of participants stated their involvement in religion/higher level of

spirituality (5-7). Unlike political affiliation where a large number of participants found

themselves answering neutrally (4), participants tended to pick a side on the influence of religion

and spirituality in their own lives.

As originally predicted, comparing self-reported religiousness scores with established

curiosity measures resulted in all negative correlations, that is, as curiosity scores went up, the

self-reported religiousness scores tended to be lower (1-3: nonreligious). As seen in Table 5,

these correlations were not significant and rather small, the highest correlation being between the

NES –TC scores and religiousness ($r = -.099$, $p = .146$) and the lowest correlation existing

between MCI – SC scores ($r = -.010$, $p = .881$).

Personal Factors vs. The Johnson-White Scale

Academic Performance. Total curiosity, and sub-facets DC and SC, all yield significant

positive correlations between curiosity scores and last reported ACT scores of participants as

seen in Table 6. When comparing TC scores with ACT scores, $r = .174$ with a $p = .036$; when

comparing DC scores (number of clicks on diversive stimuli) with ACT scores, $r = .206$ and $p = .013$; and when comparing SC scores (number of clicks on specific stimuli) with ACT scores, $r = .193$ and $p = .020$. Recall, DC and SC as sub-facets are highly correlated. This suggests in fact,

that the significant correlations that exist between academic performance and sub-facets of EC,

may be due to one of the sub-facets over the other, or in fact both of the sub-facets together. The

interaction between the sub-facets and ACT scores was examined using multiple regression

(DC: $b = .098$, $p = .107$; SC: $b = .073$, $p = .178$) revealing neither of the sub-facets to be sole

contributors to the significant, positive correlations seen when comparing DC and SC to ACT

scores individually. However, it is the combination of the sub-facets ($p = .019$) that contribute to

the predictive nature of the Johnson-White Model in regards to academic performance (see Table

7). This means, according to the Johnson-White Scale, those who hold a higher level of epistemic curiosity (desire to know, analyze, and understand)—as well as higher levels of sub-facets diversive and specific curiosity—also tended to score higher in academic testing represented by ACT scores. This result was not mirrored in the self-report measures of curiosity when comparing with ACT scores. The presence of all significant, positive correlations portrays a uniqueness surrounding the Johnson-White Scale in predicting academic performance that the self-report measures could not as both the ACT and the Johnson-White Scale are task oriented, objective measures. This means, both rely on the active performance of the individual in measuring academic performance and EC making the Johnson-White Scale a useful tool in understanding the relationship between curiosity and academic performance. The presence of significant, positive correlations hints to the importance of EC in an academic setting.

Political Interest. When comparing self-reported political interest to the behavioral curiosity measure, no significant correlations were found. The correlation closest to significance was between SC scores and self-reported political interest ($r = .093$, $p = .174$). The correlation furthest from significance is the highly weak positive correlation between gathered TC scores and self-reported political interest ($r = .026$, $p = .703$). For regression coefficients, see Table 7. These results vary greatly from that of the self-report curiosity scores, which found a highly significant correlation between self-reported political interest and self-reported TC scores for both the NES ($r = .252$, $p = 1.80 \times 10^{-4}$) and the MCI ($r = .203$, $p = .014$). This difference could be due in part to the differences between the measurements. Similar to the political interest measurement, the NES and MCI are self-report, but the Johnson-White Scale is an objective task oriented measure. Similar to how the Johnson-White Scale was found to correlate more with ACT score—an objectively gathered score to suggest academic performance—due to both

measurements' objective nature, the same is seen in reverse for political interest with the self-report measures correlating much higher than the objective Johnson-White Scale.

Political Affiliation. Almost identical to political interest, there were no significant correlations found between the personal factor political affiliation and the curiosity scores gathered by the Johnson-White Scale. The closest correlation to approaching significance is between DC score and political affiliation ($r = .126$, $p = .066$). This trend was also seen in political interest. What could attest for this similarity in correlative findings in political interest and affiliation, could be the more political based questions which appear on the NES such as: "Thinking about why politicians act the way they do," (Pearson, 1970) whereas an aspect about the Johnson-White Scale has yet to properly capture the curiosity of participants with high or low political interest and affiliation. Perhaps, this could be rectified by the addition of political based stimuli to the program.

Religiousness. Unlike the self-report curiosity measures, religiousness when compared to curiosity scores from the Johnson-White Scale shows many differences in correlations between the established measures and religiousness and correlations between the Johnson-White Scale and religiousness. Both the NES and all facets of the MCI showed non-significant negative correlations. This portrays the potential predictive abilities of the NES and MCI in predicting the likelihood of an individual's religious involvement or spiritual beliefs based off their epistemic curiosity score. In the Johnson-White Scale, all correlations are positive, however; and only TC compared to religiousness is significant ($r = .140$, $p = .040$). In Figure 7, religiousness and TC are compared, showing approximately eight high TC scores present in those with high religiousness marks ($b = 017$, $p = .040$). Due to the small fraction of participants who claimed to be religious on the survey (5-7), this handful of high scores has the potential to offset the data.

An increase in the number of religious participants would help clarify the potentially hidden trends between epistemic curiosity and religious leanings.

Discussion

Epistemic curiosity, defined by previous researchers as the intrinsic drive to know (Berlyne, 1949, 1950, 1954, 1960)—also referred to as cognitive inquiry—is unlike perceptual curiosity. Perceptual curiosity works to explain the way in which curiosity can motivate an individual to partake in exploratory behavior usually described as "physical thrill-seeking behavior". While, the Johnson-White Scale involves exploring a computer program, the aspect of physical thrill seeking is not present, but more expresses the desire to obtain knowledge and understanding that is seen in the facet of epistemic curiosity (Litman & Spielberger, 2003; Spielberger & Starr, 1994). According to Berlyne, within epistemic curiosity (EC), there are two sub-facets of curiosity: diversive (DC) and specific curiosity (SC). Using the Melbourne Curiosity Inventory Trait-Form (MCI) as an established measure of DC and SC as well as total curiosity, DC, SC, and TC scores of curiosity as measured by the Johnson-White Scale were compared to discover the validity of the behavioral measure. When comparing sub-facets of EC, DC and SC, significant and positive correlations were found between the DC and SC scores of the MCI and the Johnson-White Scale as shown on Table 3. This shows the potential for the Johnson-White Scale to be an accurate diversive and specific curiosity measure. However, it was predicted that if both DC and SC scores from the Johnson-White Scale correlated with the MCI's DC and SC scores then total curiosity (TC) scores should also correlate between the two measures. There was a positive correlation found between TC scores as measured by the MCI and the curiosity task ($r = .127$). Although not significant, the correlation is approaching significance with a p-value of .061. An increase in the number of participants from 220 could

help to raise the correlation between the two TC measures and approach significance. The Novelty Experiencing Scale (NES), created by Pearson, provides a measure of total curiosity spanning across both of what Berlyne (1954) called perceptual and epistemic curiosity (Pearson, 1970). Due to the Johnson-White Scale's design to measure epistemic curiosity and not perceptual curiosity, the NES was altered to include only questions that calculate Internal Sensation, Internal and External Cognition scores, leaving External Sensation—which too closely resembles perceptual curiosity—by the wayside. There was a lack of significance in the weak correlation (r = .060) between TC scores gathered by the Johnson-White Scale and TC scores gathered by the NES. This could be in part however, to the facets chosen to be taken out or left in the NES in attempts to isolate from Pearson's (1970) model of curiosity, what was considered epistemic curiosity in accordance with Berylne (1949, 1950, 1954, 1960), Loewenstein (1994), Spielberger & Starr (1994), and Litman & Spielberger's (2003) understanding of curiosity. A follow-up study that isolates the lack of correlation between the established NES measure and the Johnson-White Scale where multiple versions of the NES are used such as one with all four of Pearson's (1970) curiosity components, one with all but External Sensation (as used in this study), and one with only Internal and External Cognition statements would perhaps provide a more clear testament to the validity of the Johnson-White Scale. The inclusion of only External and Internal Cognition statements in an NES measure may work to illustrate the difference between sensation (PC) and cognition (EC), allowing for a more accurate self-report EC measure to be compared with the Johnson-White Scale of EC.

The four personal factors of interest in which data was gathered during the short electronic survey immediately following the conclusion of the Johnson-White Scale were: academic performance, political interest, political affiliation, and religiousness. These factors

were gathered to discover whether EC (or sub-facets thereof) is predictive of certain life outcomes such as academic success and political and religious involvement. GPA showed to be an unreliable measure of academic performance due to the average participant being in only his or her first year of college and without a GPA or with only a semester or two of classes contributing to GPA. However, self-reported ACT scores provided an appropriate measure of academic performance. An individual's tendency to seek out and understand new knowledge and mental stimulation (cognition) was predicted to yield significant and positive correlations when compared to academic performance as one who is intellectual curious may be more likely to seek out knowledge that would aid them in the academic sphere. This prediction was reflected in the Johnson-White Scale of curiosity, which found all significant, positive correlations between facets of curiosity and academic performance. Both gather a score based off the individual's behavior in the moment in relation to their performance. These abundance of correlations between academic performance and task measured curiosity levels highlight the importance in the role of academia in inspiring and nurturing epistemic curiosity.

For political interest, correlations between an individual's political interest and higher levels of curiosity as measured by the self-report measures of curiosity was found as both the MCI – TC and the NES – TC scores correlated positively and significantly with self-reported political interest levels. As seen in Table 5, as a participant's curiosity levels went up in TC and SC, the chances they were more involved in politics also went up. To be interested or involved in politics, one must be motivated by (curious about) politics. This was believed to correlate better with diversive curiosity, but the opposite appeared true as a weak negative correlation is seen between the MCI – DC scores and levels of political interest while significant positive correlations are seen with the MCI – SC and TC scores from both the NES and the MCI. The

presence of items on the NES that relate to introspective thinking about the world or a politician's way of thinking may explain the highly significant correlation between the NES – TC scores and political interest. When compared to the Johnson-White Scale, no significant correlations could be found between the Johnson-White Scale and political interest. This could be due to the lack of stimuli which could trigger a participant with high levels of political interest. Regardless, the sample lacked diversity, as 75% of participants responded with a 4 (moderate interest in politics) or a 1-3 (little to no interest in politics). This is similar to the issues seen with both political affiliation and religiousness.

Political affiliation showed promise as a correlate with curiosity once it correlated positively and significantly with the NES measured TC scores. However, this trend was not seen in any of the curiosity scores as gathered by the Johnson-White Scale. At this point, the data show no immediate relationship between a participant's political affiliation or level of interest and a participant's curiosity score. This does not necessarily mean a relationship doesn't exist but perhaps the Johnson-White Scale doesn't measure the type of curiosity that would lend itself to political interest. Perhaps political involvement and interest falls under perceptual curiosity instead of epistemic curiosity. According to the NES scores, participants with higher curiosity levels tended to be more progressive leaning and more interested and involved with politics. This in part could be due to the NES including sensation as a part of curiosity (internal sensation). With a more diverse sample, see Table 2, different results may be seen in the relationship between political affiliation and curiosity levels as determined by the Johnson-White Scale of curiosity. Currently, the sample showed to be predominantly (75%) progressive, lacking interest in politics, and nonreligious. With accurate conservative representation in the sample, correlations could be greater or less when compared to curiosity.

The most striking finding about religiousness also came (much like the rest of the personal factors) when comparing self-report measures to religiousness of participants. All correlations were negative, showing a potential negative relationship between a participant's level of religiousness and level of curiosity. None of the correlations were significant; however, a negative relationship still existed between each of the four curiosity scores (NES –TC, MCI –TC, MCI – DC, and MCI – SC) and a participant's level of religiousness. Table 2 highlights the lack of diversity in religiousness among participants as only 17.5% of participants reported any level of religiousness. Seen in Figure 7, eight participants who claimed a higher level of religiousness happened to click an abnormal amount of stimuli in the Johnson-White Scale, creating a positive correlation between religiousness and TC as calculated by the behavioral measure.

Again, more diversity in the sample, more conservative and religious participants, would help illuminate any potential relationships and the strength of those relationships. Furthermore, the elimination of a "middle-ground" option in the personal surveys would also challenge participants to evaluate individual stances more without relying on a safe neutral number (4) on which to fall back. In political affiliation, almost half of all responses were "4". A rerunning of the experiment with a more diverse sample, altered NES surveys to pinpoint epistemic curiosity, and the altering of personal factor surveys to eliminate a safe "middle-ground" number, should definitely be pursued to further understand the validity of the Johnson-White Scale and relation of religiousness and political interest and affiliation to individual curiosity levels. With a significant relationship between how curious a participant is found to be and academic performance, the importance of fostering a thirst for knowledge at a young age is key for an education seeking, academic society. Self-report measures have their own risks and validity issues associated with relying on participants to relay personal and subjective information such

as: demand characteristics (pressure to answer in line with what the participant perceives the researcher wants), the potential for negative affect to alter responses to self-report measures, and lack of ability to cross reference with an objective source or measurement (Spector, 1994; Podsakoff & Organ, 1986). A behavioral measure for epistemic curiosity, like the Johnson-White Scale, can create an objective launch pad for the continuation of cognitive research in regards to motivation and curiosity.

Acknowledgments

References

Ainley, M. D. (1987). The factor structure of curiosity measures: Breadth and depth of interest

curiosity styles. *Australian Journal of Psychology, 39*, 53–59.

Berlyne, D. E. (1949).Interest as a psychological concept.*British Journal of Psychology, 39*,

184–185.

Berlyne, D. E. (1950).Novelty and curiosity as determinants of exploratory behaviour1.*British

Journal of Psychology. General Section, 41*(1-2), 68-80.

Berlyne, D. E. (1954).A theory of human curiosity. British *Journal of Psychology,

45*, 180–191.

Berlyne, D. E. (1960).*Conflict, arousal, and curiosity*. New York: McGraw-Hill.

Collins, R. P. (1996). *Identification of perceptual curiosity as a psychological construct:

Development of the perceptual curiosity scale*. Unpublished master's thesis,

University of South Florida, Tampa

Day, H.I. (1969). *An instrument for the measurement of intrinsic motivation.* An interim report to

the Department of Manpower and Immigration.

Day, H.I. (1971). The measure of specific curiosity: In H.I. Day, D.E. Berlyne, & D.E. Hunt

(Eds.), *Intrinsic motivation: A new direction in education* (pp. 99-112). Toronto:

Holt, Rinehart & Winston of Canada

Harty, H., & Beall, D. (1984). Toward the development of a children's science curiosity measure.

J. Res. Sci. Teach. *Journal of Research in Science Teaching*, 21(4), 425-436.

doi:10.1002/tea.3660210410

Litman, J. A., & Spielberger, C. D. (2003). Measuring epistemic curiosity and its diversive and

specific components. *Journal of personality assessment*, 80(1), 75-86.

Loewenstein, G. (1994). The psychology of curiosity: A review and reinterpretation.

Psychological Bulletin, 116, 75–98.

Naylor, F. D. (1981). A state-trait curiosity inventory.*Australian Psychologist, 16*(2), 172-183

Pearson, P. H. (1970). Relationships between global and specified measures of novelty seeking.

Journal of Consulting and Clinical Psychology, 34(2), 199.

Piotrowski, J. T., Litman, J. A., &Valkenburg, P. (2014). Measuring epistemic curiosity in

young children. *Infant and Child Development*, *23*(5), 542-553.

Podsakoff, P. M., & Organ, D. W. (1986). Self-reports in organizational research: Problems and

prospects. *Journal of management*, 12(4), 531-544.

ReioJr, T. G., Petrosko, J. M., Wiswell, A. K., &Thongsukmag, J. (2006). The measurement

and conceptualization of curiosity. *The Journal of Genetic Psychology*, 167(2),

117-135.

Spector, P. E. (1994). Using self-report questionnaires in OB research: A comment on the use of

a controversial method. *Journal of organizational behavior*, 15(5), 385-392.

Spielberger, C. D., Jacobs, G., Crane, R., Russell, S., Westberry, L., Barker, L., ... & Marks, E.

(1979). Preliminary manual for the state-trait personality inventory (STPI).

Unpublished manuscript, University of South Florida, Tampa.

Spielberger, C. D., & Starr, L. M. (1994). Curiosity and exploratory behavior. In H. F. O'Neil,

Jr., & M. Drillings (Eds.),*Motivation: Theory and research*

(pp. 221–243). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc

Tables and Figures

Table 1 - reported ACT scores of participants

ACT Scores	16-20	21-25	26-30	31-35
(n) participants	5	60	60	19

Table 2 - number of participant responses to each survey option

Personal Factor	1	2	3	4	5	6	7
Political Interest	25	35	48	54	39	9	4
Political Affiliation	3	14	20	65	47	33	30
Religiousness	69	39	32	22	33	12	6

Table 3 - correlation (r) between established measures of curiosity and novel behavioral measure of curiosity

Measure	NES - TC	MCI - TC	MCI - DC	MCI -SC
TotalC	.060	.127	.170*	.138*
DiversiveC	.098	.186**	.210**	.173*
SpecificC	.130	.146*	.158*	.163*

*p ≤ 0.05   ***p≤ 0.001
**p≤ 0.01   ****p≤ 0.0001

Table 4 - correlations (r) between diversive and specific curiosity components from the MCI and JWS

Specific Measures	MCI - DC	Diversive C
MCI - SC	.626****	.173*
SpecificC	.158*	.445****

*p ≤ 0.05   ***p≤ 0.001
**p≤ 0.01   ****p≤ 0.0001

Table 5 - correlation (r) between established measures of curiosity and personal factors of interest

Measure	Last ACT	Political Interest	Political Affiliation	Religiousness
NES - TC	.164*	.252***	.162**	-.099
MCI - TC	.082	.203*	.025	-.014
MCI - DC	-.071	-.030	.010	-.013
MCI - SC	.154	.172*	.003	-.010

*p ≤ 0.05   ***p≤ 0.001
**p≤ 0.01   ****p≤ 0.0001

Table 6 - correlation (r) between novel behavioral measure of curiosity and personal factors

	Last ACT	Political Interest	Political Affiliation	Religiousness
TotalC	.174*	.026	.080	.140*
DiversiveC	.206*	.039	.126	.025
SpecificC	.193*	.093	.102	.092

*p ≤ 0.05   ***p ≤ 0.001
**p ≤ 0.01   ****p ≤ 0.0001

Table 7 - regression coefficient (b) between behavioral measure and personal factors

Measure	Last ACT	Political Interest	Political Affiliation	Religiousness
TotalC	.042*	.003	.008	.017*
DiversiveC	.098	.011	.034	.008
SpecificC	.073	.026	.024	.026

*p ≤ 0.05   ***p ≤ 0.001
**p ≤ 0.01   ****p ≤ 0.0001

Figure 1 – Main Screen of Johnson-White Scale
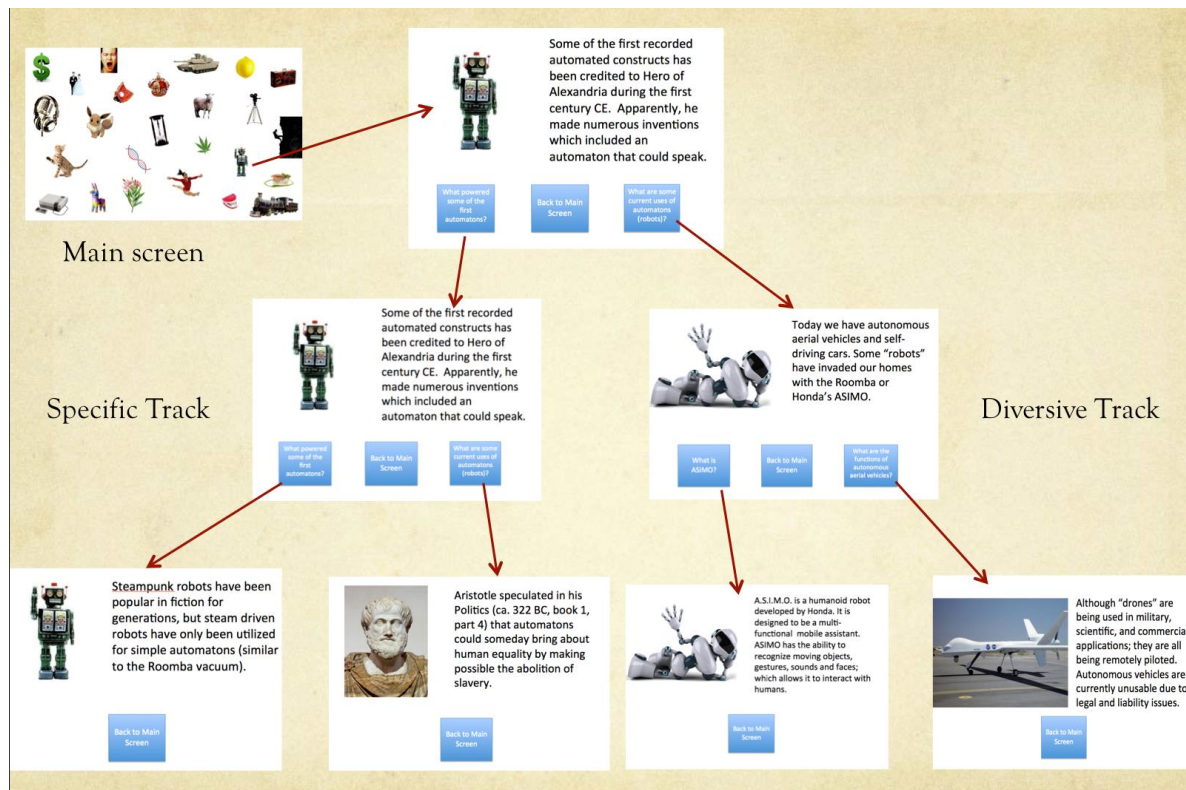

Figure 2 – Breakdown of Tiers in Johnson-White Scale

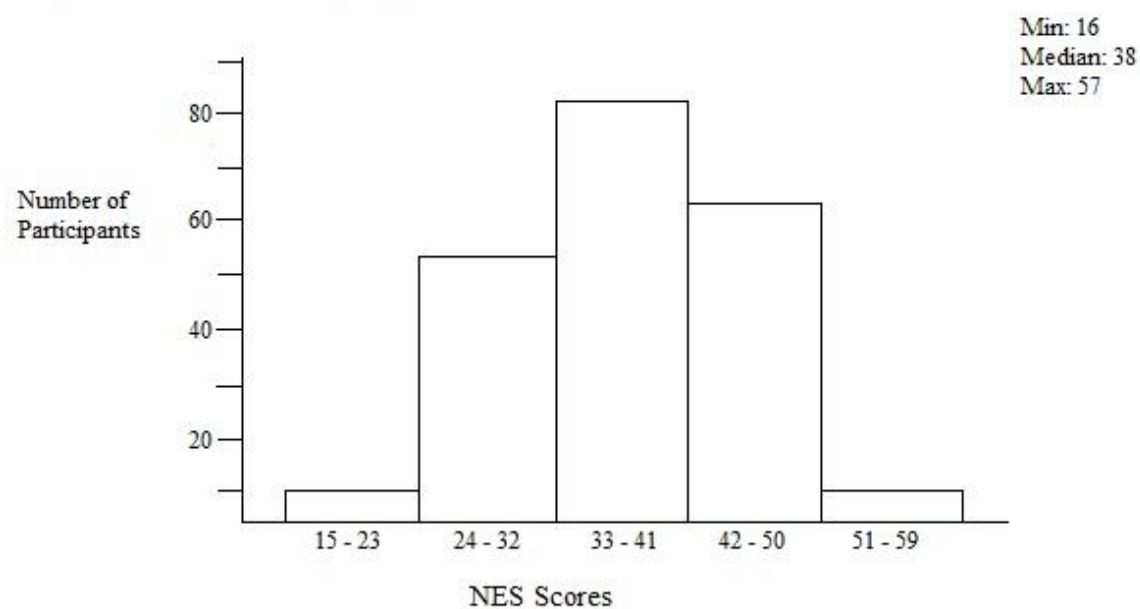Figure 3 - NES scores of participants

Min: 16
Median: 38
Max: 57

Figure 4 - MCI scores of participants
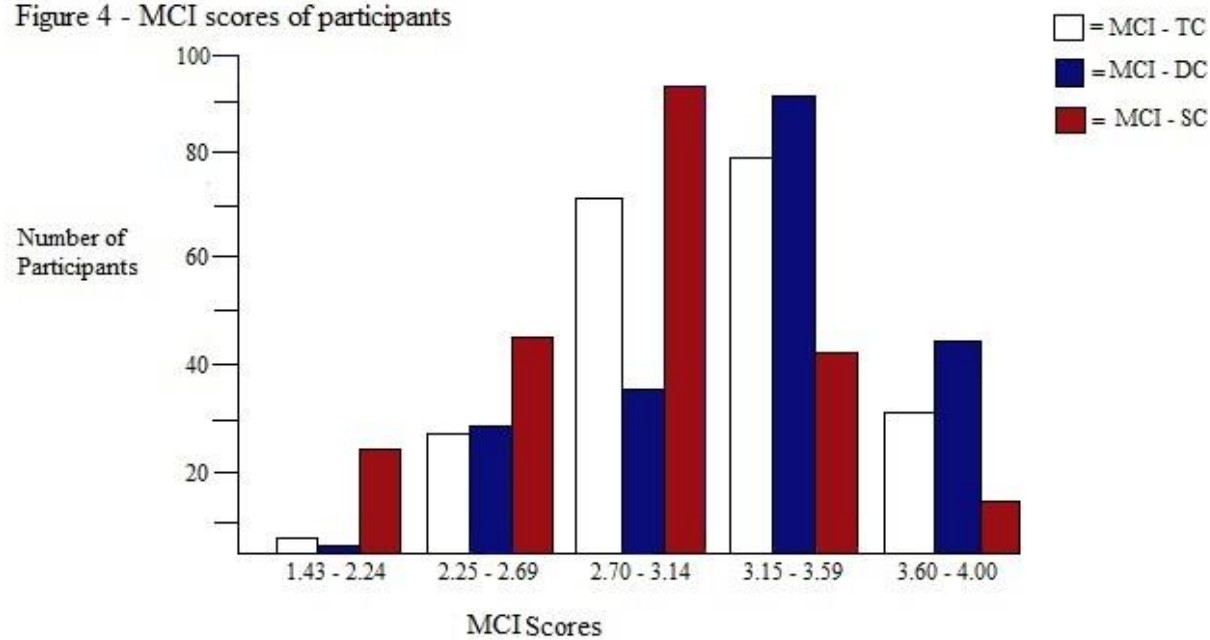

□ = MCI - TC
■ = MCI - DC
■ = MCI - SC

Figure 5 - JWS diversive and specific curiosity scores of participants
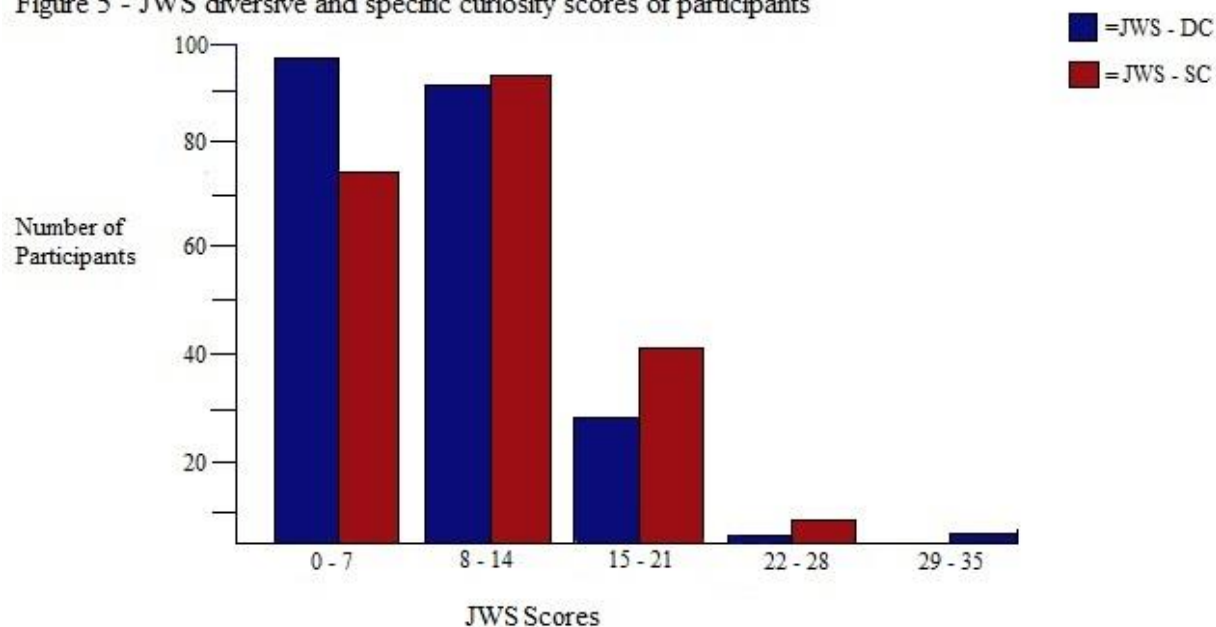

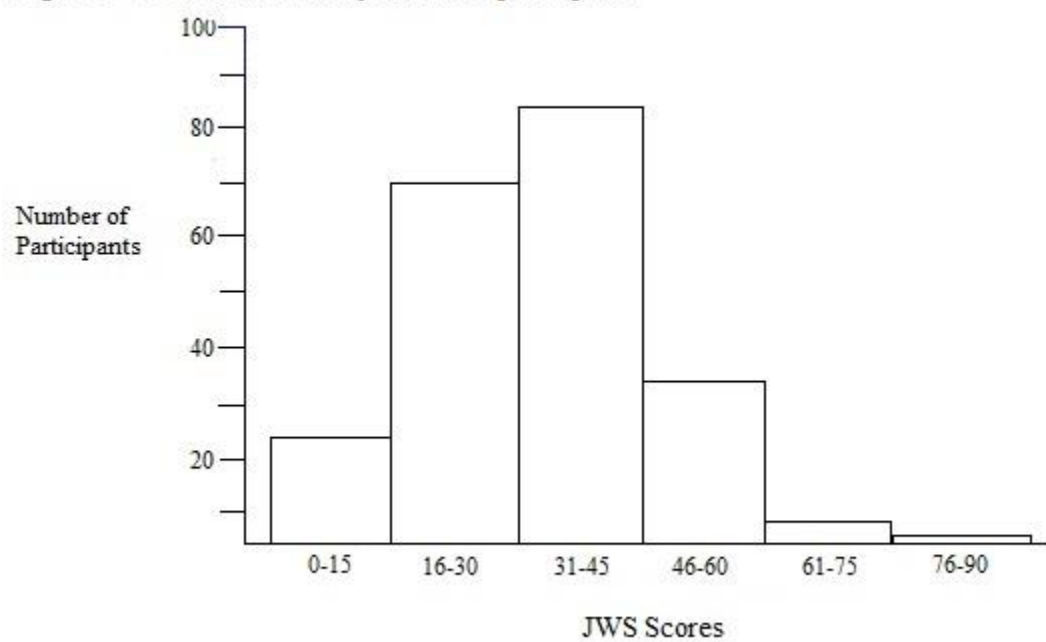Figure 6 - JWS total curiosity scores of participants

Figure 7 - Religiousness vs. Total Curiosity

Total_C = total curiosity