ABSTRACT
There is lot of research going on currently in identification of Autism and also identification of characteristic in autistic people. There is lot of theories put in place. But one of the main issues has been how to measure these characteristics. There has been so much of research in analysis of creativity in autistic individuals. These research works have enlightened so many positive traits which could be well used for development of autistic individuals. But the major drawbacks have been lack of well defined model for analysis and hence lack of statistical data.

We understand that one of the major issues with autism has been high variation in characteristics of autistic individual. And these characteristics differ from geographical locations. This brings in a need for flexible mathematical model to which N different characteristics can be added or removed based on geographical location or sex of individual under analysis. This paper contributes by proposing a simple algorithm for building a software framework which would help in collection of data and represent them quantitatively.

The Quantifiable representation will be a table. Each row will have a personality with high functioning autism who has been very creative in his field. Each element in a column will denote a autistic characteristic exhibited by the personality and each cell will have a value based on characteristic observed in the personality. This table is called a reference table.

Each characteristic represented in the column is derived from analysis of different creativity theories and trying to derive the creativity characteristics specific to autistic individuals.

Keywords
Autism, positive creativity, systemizing

INTRODUCTION
What’s Autism- It is developmental disorder that appears in the first 3 years of life, and affects the brain's normal development of social and communication skills. The first major analysis would be to understand what creativity and autism is and how to relate them. The important question is can creativity and autism complements each other? Some common, characteristics found in autistic individuals includes Unconventional, Unorthodox, Identity Diffusion, Tremendous honesty and openness, Eccentric Behavior, Non-verbal Behavior

Creativity Vs Autism
The world The details
Novelty Repetition
Hungry to feel Blocked to feel

The simple comparison table above gives the contrasting characteristics of creativity and autism, while all we have learned is creativity is about understanding the world and events that occur around. Creativity is also about novelty, where new ideas come into play. These ideas could be in response to a problem or futuristic research too. Novelty could also be thought of as an out of the box idea. It also indicates the hunger for people to think some thing creative to come up with creative idea.

The autism characteristics presented in the table is complement with creativity. People with Autism care more for details on something specific rather than thinking about the world. For an autistic person to understand an activity or process it requires frequent repetition of activity to get a hold of it.

'Blocked to feel' just indicates absence of thoughts or inhibition to think about emotions. This raises an important question of then what aspects can bring in creativity in autistic individuals.

Modern views on creativity
New ideas do not emerge accidentally or randomly and creativity is not based on a spontaneous, unique and analyzable subjective processes.

New idea may arise as a sudden insight that is, however, preceded with a relative long period of working with a problem

Creative processes and mechanism can be analyzed, explained, and understood scientifically!

By learning to know processes involved in creative activity, we may learn to help people to become more creative.
3. LITERATURE

In the following sections we would refer to set of previous works in field of creativity and related them to creativity in autism.

3.a Flow experience (Csikszentmihalyi, 1993)

This work (3) on Flow experience describes on what factors results in a unique creation. A peak experience in which a person concentrates on some activity so deeply that he or she temporarily forgets all worries or uncertainties related to his or her competency or life situation. Flow represents enjoyment of activity that leads to human development and increased complexity of his or her activity. In order to experience flow, people need to work at the edge of their competence and surpass themselves.

As described earlier, people with Autism show similar characteristics deeply engrossed in an activity. They lose the sense of external world. The deviation of thought is almost absent. These characteristics are self sufficient to describe that flow experience is an important characteristic that needs be considered during quantification of autistic individuals.

3.b Empathizing and systematizing theory

Empathizing and Systematizing theories are one of the major theories that have been very suitable for differentiating between autism and creativity.

Empathizing - connecting peoples thoughts
Systematizing – doing something mechanically

According to the empathizing– systemizing (E-S) theory, autism and Asperger's syndrome are best explained not just with reference to empathy (below average) but also with reference to a second psychological factor (systematizing), which is either average or even above average. So it is the discrepancy between E and S that determines if you are likely to develop an autism spectrum condition.

Empathizing: It is mainly referenced with condition of empathy which indicates a below par condition. With autistic people this fits well with the condition of inability to communicate

Systematizing: It is mainly referenced with condition of average or above average. It basically indicates an ability to build systems. The systems could be of varied forms from mechanical systems or design systems.

What we are interested is the Systematizing part of the theory. This is because extensive research in autism has proved that people with Autism have a strong systematizing skills. For building any system, one may have to follow set of rules. Hence given a set of rules, people with systematizing skills have the ability to visualize how the systems would behave which greatly aids in construction of a system.

This means that given a rule P, and a rule that if P happens the Q also happens, and then constructing a system based on this fact is the basis of any analysis and design. This directly provides a fundamental reason on why people with Autism have been outstanding in area of mathematics and physics.

Some of the examples that we refer later in our method of evaluation are highly successful people with strong systematizing skills. Hence we would be interested to take the systematizing trait in our method of estimation

General form of Systematizing: The paper on systematizing and empathizing theory lists some interesting areas of systematizing. Here we list some of the most relevant kinds of systematizing which would match the examples we use to evaluate as reference

• Numerical systematizing
  ◦ Obsessions with calendars or train timetables
  ◦ Solving math problems
  ◦ Spatial systematizing
  ◦ Obsessions with routes
  ◦ Developing drawing techniques
  ◦ Musical systematizing
  ◦ Playing a tune on an instrument over and over again
  ◦ Analyzing the musical structure of a song

The theory divides humans into scales

Type E (E > S): individuals whose empathy is stronger than their systematizing

Type S (S > E): individuals whose systematizing is stronger than their empathy

Type B (S = E): individuals whose empathy is as good (or as bad) as their systematizing

Extreme Type E (E >> S): individuals whose empathy are above average, but are challenged for systematizing

Extreme Type S (S >> E): individuals whose systematizing is average, but who are challenged when it comes to empathy

Autistic people fit into the last type where S is comparatively highly greater that E. Hence from the above description we can derive the characteristics of systematizing.
3. c Two types of creativity

Exploration & exploitation (James March, 1999)

Exploitation and Exploration is a interesting theory which was proposed as business creativity model. But creativity by its term can use analogy from different fields and that is why we would be using this for understanding creativity in autism. Below is a very simple definition of Exploration and Exploitation which would make It obvious on how we would be using it in our derivation of characters.

Exploration: Searching, creating, exploring and discovering ideas and innovations

Exploitation: Refining, applying, and using knowledge, and forming routines

It is pretty clear from the definitions that Exploration is all about creativity in terms of novelty, where as exploitation is creativity derived from constant exploration of the problem which infers exploitation. As we had discussed earlier, autistic individuals rely on repetition and can apply & grasp small modifications at a step. Hence the characteristic of exploitation better suits in analyzing creativity when compared to exploration.

3. d Progressive problem solving (Bereiter & Scardamalia, 1993)

Progressive problem solving is a process of generating expert knowledge through the continual reinvestment of mental resources into addressing problems at higher levels.

- Reinvestment in learning is iterative learning.
- Seeking out more difficult and challenging problems
- Forming more complex representations of recurrent problems

A characteristic of progressive problem solving is to undertake more and more challenging problems and to work at the edge of one's competence. We derive the character Progressive problem solving from this literature.

3. e Central Coherence Theorem– Connecting events

Every human has his own way of thinking and some of them are very much predictable and similar between humans. Hence one person is able to predict certain beliefs of other person or have a theory of Mind of other person. Theory of Mind states that, Autistic person do not understand the thinking of other humans, and so it means that Autistic people do not have theory of Mind. A simple study named Sally-Anne test was conducted to prove this theory. This is a popular test and its result lead to formulation of number of theories.

There are two dolls, Sally and Anne. Sally has a basket in front of her and Anne has a box. Children, after being told the names of the dolls, are asked to confirm that they know the names of the two dolls. When you are familiar with the experiment you should consider why the 'naming' question is important.

Sally places a marble in her basket. Sally goes for a walk (disappears from view). While Sally has gone, Anne plays a trick and takes the marble from Sally's basket and transfers it to her (Anne's) box. Sally returns.

The child is asked the main experimental question (the 'belief' question). "Where will Sally look for her marble?"

The correct response being "in Sally's basket", because that is where Sally left it, and she is unaware of Anne's trickery. Incorrect response being "in Anne's box", because Sally does not know this and the child is just telling the experimenter where the marble really is (where they believe the marble is). This would demonstrate an inability to consider what Sally's beliefs are.

Here are the results of the study. All of the control questions (Naming, reality and memory) were answered correctly. The belief question was answered correctly by 20% of the autistic children, compared to 86% of the Down's syndrome children and 85% of the four year olds. This suggests the autistic children could not appreciate what Sally believed. They lack a theory of mind. This experiment was the basis for Weak Coherence Computational Model. We would not be representing weak coherence model in our sample reference table as it could become extremely complex in its representation.

3. f Thinking In Pictures

Thinking in pictures basically underlines the fact that people with autism are better able to capture sequences depicted in picture when compared to task that require verbal communication or verbal understanding. This is majorly because of the fact that they are better able to connect events in form of picture.

There is a strong acceptance among researchers that people with Autism are gifted to visualize things better and pictorial representation. One of the high functioning autism personalities Dr. Temple Grandin quotes “Words are like a second language. I translate both spoken and written words into full-color movies, complete with sound, which run like a VCR tape in my head. When somebody speaks to me, his words are instantly translated into pictures” . Another indicator of visual thinking -remarkable ability solving jigsaw puzzle. This clears the fact that people with autism are not visually following the snapshot of pictures or sequences but also creatively think and develop further sequences using these pictures.

The Ravens progressive model is a strong indicator of this. Ravens progressive model is a pictorially designed puzzle. Children with Autism have generally performed better in these tests compared to children of same age with out any complications.
4. DESIGN

4. a Identification of creativity in Children

The basic problem with Autism is identification of autistic condition. This is a major area of research and some of the identification techniques though having been successful is yet to be proven. Since we are dealing with positive creativity, based on study we can classify condition of autism based on the below factors.

The table below shows representation of characters that could present in both non autistic child and an autistic child

| Variety of Interests | Excellent memory | Long attention span | Persistence in attacking difficult mental tasks | Creative ability/Divergent thinking skills | Good problem solving/reasoning abilities | Rapid learning ability | Leadership qualities | High degree of energy | Above average language development | Early/avid reader | Preference for older/matured companions | Heightened sensitivity | Keen powers of observation | Vivid imagination | Good sense of humor | Sense of justice and moral sensitivity | Perfectionism | Apparent maturity in judgment | Unusual curiosity | Unusual emotional depth and intensity | Above average ability with numbers/jigsaw puzzles | Non-conformity behavior |
|---------------------|----------------|-------------------|-----------------------------------------------|------------------------------------------|----------------------------------------|----------------------|---------------------|-------------------|--------------------------------------|--------------------|--------------------------------------|------------------|------------------------|----------------------|-------------------------|------------------------|-------------------------|------------------|--------------------------|---------------------|---------------------|-----------------------|------------------|
| Jerry Newport       | 4              | 5                 | 3                                            | 3                                        | 3                                      | 3                    | 3                   | 3                 | 3                                    | 5                  | 5                                    | 3                | 3                      | 3                    | 3                       | 3                      | 3                       | 3                | 3                       | 3                  | 3                    |
| Ramanujam           | 5              | 1                 | 5                                            | 5                                        | 5                                      | 5                    | 5                   | 5                 | 5                                    | 5                  | 5                                    | 5                | 5                      | 5                    | 5                       | 5                      | 5                       | 5                | 5                       | 5                  | 5                    |
| Satoshi Tajiri      | 3              | 1                 | 3                                            | 3                                        | 5                                      | 5                    | 5                   | 3                 | 5                                    | 5                  | 5                                    | 5                | 3                      | 3                    | 5                       | 3                      | 3                       | 3                | 5                       | 5                  | 3                    |
| Tito                | 2              | 5                 | 3                                            | 3                                        | 2                                      | 5                    | 5                   | 5                 | 5                                    | 5                  | 5                                    | 5                | 5                      | 5                    | 5                       | 5                      | 5                       | 5                | 5                       | 5                  | 5                    |

4. b Biggest challenges

This section represents some of the biggest challenges and motivation behind this paper. Though there have been several ideas, concepts and even books published about creativity in autistic people, there has not been any work which specifies how to analyze creativity. Also to our knowledge there does not exist a standard or a model or a definite methodology for this.

a. Lack of proper data collection methodology
b. Its understandable that the non existence of mathematical model relates to issues in data collection and identifying a pattern. This can be stated as more importantly, lack of proper method of collecting data to derive mathematical model solution

Problem a and b are non mutually exclusive properties and are dependent on each other

Design a simple generic algorithm and bring about customization. Hence to derive a and b, there needs to a simple algorithm as a catalyst. But to our knowledge such a algorithm does not exist. Hence this papers main contribution would be propose such an algorithm which we believe would be simplistic, pragmatic and easy to design as software.

4. c Quantization Process

As a first step towards Quantification process, we go about building a reference table. The reference table is populated with different scores of various high functioning successful autistic individual

This table forms a major backbone for this paper in identifying the skills of creativity among autistic children and also deriving a pattern using well known example

Mozart and the Whale: An Asperger's Love Story, Jerry Newport is an author with Asperger syndrome whose life was the basis for the 2005 feature-length movie Mozart and the Whale. He is known for his frank advice and humor when giving presentations. He is also a savant with the ability to perform extremely difficult and intricate mathematical calculations entirely in his head.

Satoshi Tajiri has been diagnosed with Asperger’s syndrome. He has been described by Nintendo officials as exceedingly creative but "reclusive" and "eccentric"

Autism speaks quotes “Tito remarkable young man with a special talent. Severely autistic and nearly non-verbal, Tito can communicate his thoughts and feelings through remarkable prose and poetry - written in fluent English. Tito's view of the world provides an extraordinary opportunity to explore the hidden world of autism “

Ramanujan is an Indian mathematician and classic traits of Asperger's syndrome are shown to have coexisted with an extraordinary level of creativity

4. d Rationality in scoring

For the reference example used, let’s discuss the scores in table and personalities in the reference table. Though we would not be discussing every character in our reference table discussing few characters would be very useful.

Variety of Interest: Jerry New Port though he was autistic showed variety of skills in different fields like film making, art and also he was a mathematician. Hence a score of 5 for the variety of interest section. In case of Ramanujam, he was just interested in mathematics and nothing else which is why he was given a score of 1
Systemizing: Ramanujam was a mathematician and required constant systemetizing working iteratively on finding solutions to problem and that is the reason one can find the score of 5 in the corresponding cell in the table.

Exploitation: In case of Satoshi Tajiri one can find the score of exploitation being 5. As we had discussed, reading the biography of Satoshi, one gets an impression that poetry is just not novelty, but constant thought and iterative modification over a period of time. This end result of this iterative modification would give an image of novelty although in the background it is just exploitation.

Non Conformity: Tito was a video game designer. His colleagues described him as highly eccentric. Most of his activities kept his colleagues puzzling. He was sunk in his game design and would not know most of the times what was going around

5. ALGORITHM

1. Identify each specific character described above for subject under analysis. Identification is a difficult and different area of research

2. Tabulate the score against the scale for every character defined

3. Finding the closest match

   a. For every set of input, compare every specific character (Ci) in the subject table with reference value (Rj). Note that the subject table will have only one row.

   b. Find the difference of (Rj- Ci)

   c. If difference > threshold (Tj), then specific character (Ci) does not match with reference value. So the specific character should be dropped.

   d. Find the sum of all characters that needs to be considered and find the difference with sum from reference (Rj)

   e. Repeat step 3 with every reference character and find the closest match with a reference character.

Once a reference table has been formed, then for every character under study a similar table needs to be formed called the subject table. The subject table will have only one row and the reference table could be as large as number of reference personality. More the number of rows, better it would be for study.

5. a Advantages of Current Method

All the data are represented as numbers. Hence quantification becomes easier.

One of the issues regarding Autism has been inability to share data due to huge variations in data and also representation of data

This provides a method to analyze the pattern. It does not mean this will be a fool proof method. As the data collection increases the perfection ratio would be better.

One of the solutions would be to use our home grown solution for collecting data from every individual using a rapid autism screener called Rapid ABC. The work was presented in the IMFAR Chicago (Rapid ABC)

This would help in information sharing across borders.

5. b Alternative models

The above proposed model is just one of the models that have been stated. There can be several alternative models that may work better tomorrow when compared to current situation. But since thus above proposed algorithm is generic it can fit into alternative models also. For example below is a representation of a model that was used to scale the creativity of undergraduate students entering a 4 year engineering program. But this model has been modified slightly to take autistic children into account. This method is called a variable mean rating method where every character is scaled for a value of 5 and then the student is analyzed.

5. c Variables Mean Rating

<table>
<thead>
<tr>
<th>Variables Mean Rating</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revise a previously held view to account for new information</td>
<td>4.1</td>
</tr>
<tr>
<td>Determine associations between similar ideas, objects and situations</td>
<td>4.07</td>
</tr>
<tr>
<td>Ability to make constant improvisations</td>
<td>4.1</td>
</tr>
<tr>
<td>Emotional changes when finding a solution to problem</td>
<td>3.1</td>
</tr>
</tbody>
</table>

6. Related work

As mentioned data collection is one of a difficult task to accomplish with respect to autistic children. Its a long process not because it is time consuming, but it is very difficult to confirm on a result and would take several visits of the child. As a part earlier work at Georgia tech a system called “Rapid ABC” was developed which was used for quick identification of autistic characters in children. As a part of identifying characteristics, a quick 3 minute screener was developed and the result of analysis was stored in automated system that could scan the screener, pick results and quickly save across remote databases. Such a screener could be used to analyze the characteristics mentioned above in the reference table and create a corresponding subject table which is a very important step towards application of algorithm.

Conclusion

The major aim of the paper was to not only to propose an algorithm but was also to show that different works in the field of creativity can be mapped to creativity in autism. Followed by identifying the characteristics, the contribution of paper was to propose an algorithm using the following identified characteristics. Though the algorithm is not very
exhaustive or does not deal with every case, we believe such an algorithm would give a head start to think autism creativity in quantitative terms. This could help to build better systems and hence more flow of information thereby resulting in sharing of information across boundaries. This way every autistic child could be tuned to move in the direction of better creativity. Measuring creativity in Autistic individuals can be very productive towards grasping and thereby shaping individuals based on the inherent creativity.

**FUTURE WORK**
Currently, the proposed algorithm is a simple algorithm implementation which considers basic requirements. One of the future works would be to scale it into user friendly software that can be used by pediatricians, researchers and also autistic individuals. This should follow with development of more generic models.

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