**Loom History:**

Currently, Loom has gone through 2 iterations of data collection and is on the verge of publishing the second paper for the latest data set. In the first paper we were able to characterize how a virtual presence affects individual measures of gaze, movement, and arousal in autism. While interesting, due to the novel methodology of the game, this does not really answer any questions about how social interaction is differently formulated and performed in autism. Which is really the goal of using a dynamic social interaction game like Loom. At best we can say that there are certain instances in movement and gaze behavior where timing is different in autistics compared to non-autistics, but these individual differences have mostly already been discovered in smaller isolated experiments. It is encouraging that a lot of the results for the first version of Loom are in alignment with the previous research. The gaze data for the view wall is particularly interesting because it shows a skill that autistics have for static search and detail detection in the context of a highly dynamic situation, rather than a deficit in ability. From our current metrics, this was the only example of autistics being better than non-autistics as the other data for gaze and movement was found to be statistically similar or autistic people were slower compared to controls. These differences for gaze and movement, as well as the hyperarousal response mostly occurred in the cooperative condition of the game. This result potentially indicates that the introduction of a social presence in the VR environment differently affects autistics in the domains of gaze, movement, and arousal.

I would like to use the current data set to say something more specific and relevant to social interaction than simply characterizing difference in autistic individuals. Unfortunately, articulating how these characterizations explain anything about social interaction is difficult. Some of the reasons for his include direct challenges to the findings like:

1. This is a virtual environment and may not fully mimic a real social interaction.
2. The differences found between the groups are caused by something indirectly associated with social interaction such as visual or game complexity. *This covariate would have to be present only in the cooperative condition since that is where we see the majority of group differences.*

And more indirect challenges regarding the conceptual nature of social interaction in general. Simply, it is difficult to describe specifically why autistic individuals are incapable of fluid social interaction, when we do not really have a baseline for what comprehensive social interaction is.

**Finding a Research Question that incorporates multiple domains of autism and social interaction**:

Some autistic characteristics are easier to extrapolate as to their effects on social interaction such as, the use of gaze when making (or not making) eye-contact or the lack of accuracy when identifying human emotions and social ques. However, these examples are difficult to contextualize more broadly about social interaction because of the aforementioned lack of specificity on the topic. These predominantly visual and cognitive characteristics of autism could be related to the other autism specific differences that have been reported such as the issues with motor control. Combining these domains is an important step for the autism field because of the high likelihood that there is an underlying reason for both occurrences. This reason, whatever it is, could be a vital piece of information for understanding the challenges that autistic people have with social interaction and developing practical clinical applications. Currently Loom cannot do mechanistic research that would require neuroimaging techniques like EEG or fNIRS (possibly a future addition to the system) which would provide more tangible evidence for a connection to the domains of gaze movement and arousal, but it may not be necessary to at stage and most likely could be used to validate any findings that we make from the current data. Therefore, I believe that my task must now be to find a measure that answers the questions:

**Q1:** How do autistic individuals combine the use of gaze & movement (and possible arousal) differently than non-autistic people?

**Q2:** Do social stimuli impact this combination?

**Measure Combining Movement and Gaze and Arousal:**

This is not an entirely new avenue of thought as many researchers have started to examine the relationship in perception and action in

One possible question involves the use of gaze, head position and hand position, and how each of these three different motor movements are leading the others.

This study

Outlines a potential question about how autistic people are using their gaze and head movement in coordination differently than non-autistic people.

Motor abnormalities in autism (Fournier,Hass,Naik,Lodha,&Cauraugh,2010) have been found in many instances, however there is a large amount a variability in these findings and it is unclear as to why. Obstructed development or interventions could be the cause. Difference in neural physiology have also been consistently observed in autism. Specifically in cerebral hemisperes, caudate nucleus, and cerebellum. Additionally less integration among brain regions have also been found in autism. Decreased connectivity across the motor execution network relative to children with normal neurodevelopment could be one reason for the difference we see in motor control.

These motor abnormalities still do not really get us that much closer to the issues found with social interaction.

**Literature concerning the combination of Movement and Social Interaction:**

# This paper: So close yet so far: Motor anomalies impacting on social functioning in autism spectrum disorder – Casatelli et al

<https://www.sciencedirect.com/science/article/pii/S014976341530258X?casa_token=cuEVAP19BoUAAAAA:nNyS5Ksjwd_sqVBNF6Bg2wBDDzkz6IUJ0JqqNn_F_n92wfyX38tffzihl_g-cKCcDD7v_LMM#bib0095>

Describes terms which could roughly outline a conceptual foundation for the different kinds of connections that exist between social interaction and movement. These terms are and “motor resonance” and “motor interference”

**-Quote:** “Referring to ASD, the first one can impact the ability to directly understand (i.e., motor-based understanding) others’ behavior, whereas the second one may be considered a more general and pervasive motor marker of social anomalies.”

**Motor Resonance:** The type of evidence that is given in the paper for motor resonance is focused on the differences in the motor planning and visual observation of movement that occur in autistic people. For example ([Cattaneo et al., 2007](https://www.sciencedirect.com/science/article/pii/S014976341530258X?casa_token=cuEVAP19BoUAAAAA:nNyS5Ksjwd_sqVBNF6Bg2wBDDzkz6IUJ0JqqNn_F_n92wfyX38tffzihl_g-cKCcDD7v_LMM#bib0115)) is a really cool experiment that uses EMG attached to the mouth muscle to record activation on a task that asks autistic and non-autistic kids to preform two actions. Action 1) Picking up food and putting it in the mouth and Action 2) picking up food and putting it into a bin. The autistic group showed a late mouth activation occurring after the grabbing portion of the action in difference to the non-autistic group who did. Implying that there is some kind of neurological issue affecting the functional activation of movement and impacts motor planning. Interestingly, this study also contained a second “observational” condition where the participants watched someone else do both actions. The non-autistic group showed similar mouth activation while watching some preform the eating action but the autistic group showed no activation while observing either action. Both of these results imply that the autistic group has difficulty visually encoding the goal of an action, which is more pronounced in a purely observational situations. The Casatelli paper also cites another paper:  [Boria et al., 2009](https://www.sciencedirect.com/science/article/pii/S014976341530258X?casa_token=cuEVAP19BoUAAAAA:nNyS5Ksjwd_sqVBNF6Bg2wBDDzkz6IUJ0JqqNn_F_n92wfyX38tffzihl_g-cKCcDD7v_LMM#bib0050) which further highlights this inability to infer intention from specifically motor cues.

A diagram of a autism spectrum disorder

Description automatically generated

This is purely speculation as there is no evidence concretely connecting these concepts, but they could be avenues for future research. The connection of these domains more tangibly, could be a problem that Loom could help address. With Loom, we can measure the free use of gaze, movement and arousal in a highly temporally dynamic manner. In a paper: <https://www.sciencedirect.com/science/article/pii/S014976341530258X?casa_token=cuEVAP19BoUAAAAA:nNyS5Ksjwd_sqVBNF6Bg2wBDDzkz6IUJ0JqqNn_F_n92wfyX38tffzihl_g-cKCcDD7v_LMM#bib0095>

These two examples are given terms while attempting to connect social interaction to movement.