CIRCLE TRACKING GAME

TESTING COORDINATION

Master's Thesis

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Negotiation and Perspective Taking in VR

The goal of this project was to study the effects of immersive virtual reality simulations on increasing understanding, empathy, and cooperation among people, as compared to traditional perspective taking methods. Using traditional media, perspective taking is usually encouraged via imaginative methods (e.g. asking an individual to imagine that they have become someone else), or through storytelling, which is usually depicted in text, video, or live performance by actors. For over a decade, researchers at the Virtual Human Interaction Lab have studied how experiences in immersive virtual environments can impact individuals differently than these more traditional perspective taking experiences.

During the course of this project, immersive virtual reality software and hardware was used to produce Virtual Reality Perspective Taking (VRPT) experiences. With VRPT, personal connection is inherent as the technology is designed to respond to the user's own body movements. These VRPTs also included a number of interactive elements, allowing the user to engage with the content and change the outcome of the experience with their behaviors. By inhabiting the body of another person, the user has an increased sense of presence in the experience as well – as if it is actually happening to them. With these benefits in mind, we hypothesized that the proposed project will reveal the benefits of VRPT in increasing understanding and cooperation.

We proposed that VRPT can potentially increase cooperation through four distinct causal pathways. Because these distinct causal pathways are implicated in some cooperative settings but not others, we can systematically manipulate the game-theoretic structure of cooperative settings to help test our claims. We aim to analyze the effects of VRPT on cooperation in social dilemmas-- situations featuring distinct barriers to cooperation in order to test our reasoning.

Coordination Games

The goal of this project is to study the effects of immersive virtual reality simulations on increasing understanding and cooperation among people through three distinct causal pathways. First and foremost, Selfishness; people may defect rather than cooperate in order to achieve greater personal profit. Next we have Distrust; people may defect because they fear the other will exploit them. And lastly, we have Coordination; people may fail to cooperate because they do not accurately anticipate the other's behavior.

In order to examine the three pathways we elected 3 games to include in our study. The dictator game by Kahneman et al. (1986b), allows gives us insight into selfishness. The game has the first player decide how to allocated a certain number of points he or she is given at the start off the game between themselves and the second player. He or she is told that their earnings will correspond to the points that they will end up with after the game and get to decide how many points to keep for themselves and how many to send to the second player. The Trust Game, designed by Berg et al. (1995) examines trust between two players. It starts with one player being allocated a certain amount of points that he or she gets to send to the second player. The points are tripled and sent over to the second player, who gets to decide how many points to keep for themselves and how many to send back to the first player. Same as the dictator game, the points correspond to the earnings received at the end of the study.

For the third pathway, there exist a lot of different variations of coordination games such as the Driving Game, Battle of the Sexes, and Stag Hunt. In this type of game, each player chooses between two options without knowing what their partner picks. The have to cooperate to achieve a more desirable outcome for both. Choosing the same option usually results in the greatest option.

	Left	Right
Left	10, 10	0, 0
Right	0, 0	10, 10

Fig 1. Driving Game

	Opera	Football
Opera	3,2	0,0
Football	0,0	2,3

Fig 2. Battle of the Sexes

	Stag	Hare
Stag	10, 10	0, 8
Hare	8, 0	7, 7

Fig 3. Stag Hunt

The figures above demonstrate the scenarios in question. In the driving game, if the players pick opposite sides to turn they will get in an accident. So their goal is to pick the same side, regardless of which side they chose. In Battle of the Sexes a husband and wife need to choose whether to go to the Opera (which the wife prefers) or to a Football Game (which the husband prefers). But ultimately they would strongly prefer to be together regardless of the activity. The Stag Hunt requires both players to cooperate to “kill” a stag which is worth more points, but allows them to “kill” a hare without help for less points.

We examined these for a while, but decided that ultimately, we wanted to experiment and create our own coordination game which would have players work together to achieve a physical task. We opted for a circle tracking game which is described in more details in the next section.

Designing The Circle Tracking Game

In order to measure coordination, we created two qualtrics surveys - a pre treatment questionnaire to measure baseline attitude of the participant and one post treatment to observe behaviour following VRPT.

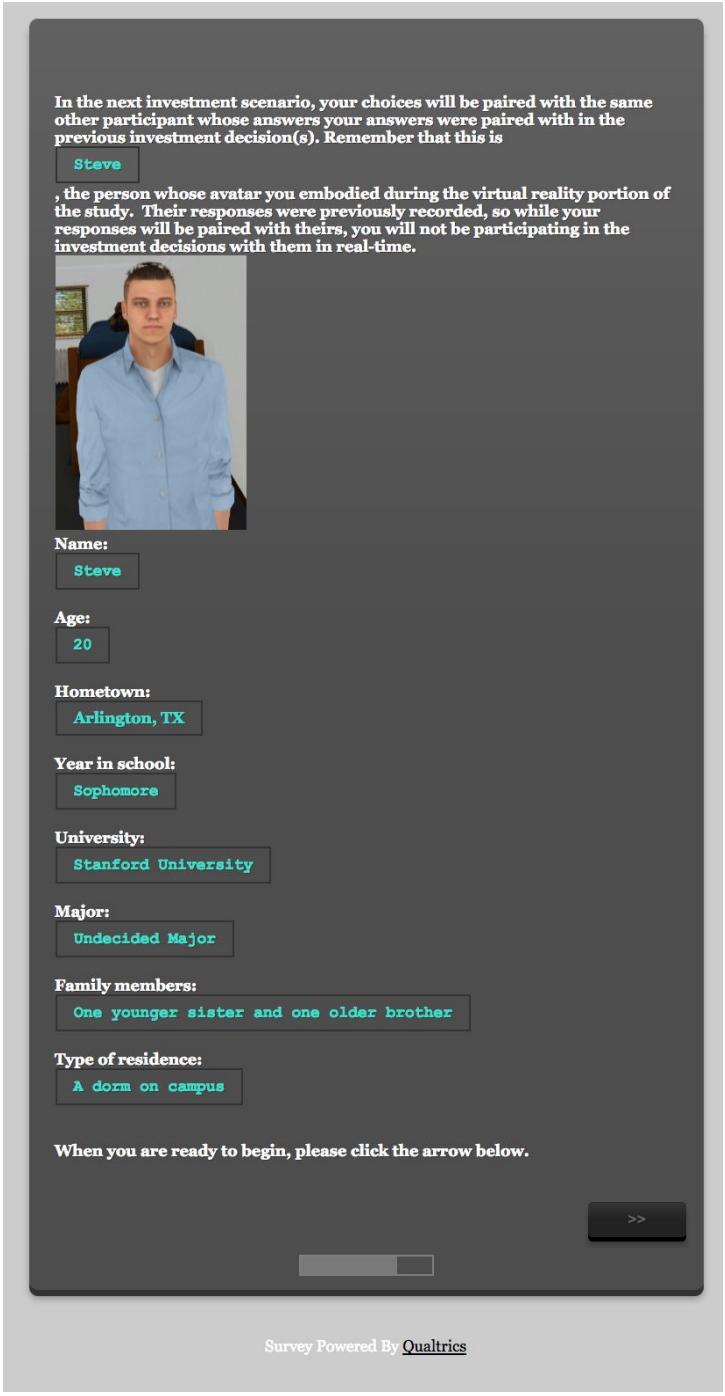
The post survey consisted of three components. First the subject played the Dictator Game, then the Trust game and finally, the Circle Tracking Game, a coordination game of our creation. The participant was tasked to control a hoop with their cursor and attempt to follow a small dot around the screen for one minute. The hoop turned green when the dot was contained inside it, and red when the dot left the area or the hoop or stopped moving altogether. We calculated the time of the overlap in milliseconds and tracked the coordinates of the hoop for the length of the game.

When we first designed the game, we experimented with three hoop sizes - a small, a medium and a larger size. We observed that the small one was too difficult, and the larger one too easy. The movements of the small dot were pre-recorded. We experimented with three different speeds, or difficulties, recording a new path numerous times. Before starting the game, the participant got a fifteen second practice round with them moving the hoop around the frame without a dot to follow. Part of this was meant to play into the illusion that they are playing this game with Steve or James by making it believable that their motions could have been recorded for a future participant to play against. Our experiments only had one participant at a time so we used the same recording of the dot for everyone and replayed it so as to have consistency when analyzing our data.

For a screen by screen demonstration of the final outcome, see appendix below for screenshots. The game was created in javascript and embedded in Qualtrics. See Appendix for detailed code.

APPENDICES

APPENDIX A: SCREENSHOTS OF FINAL GAME



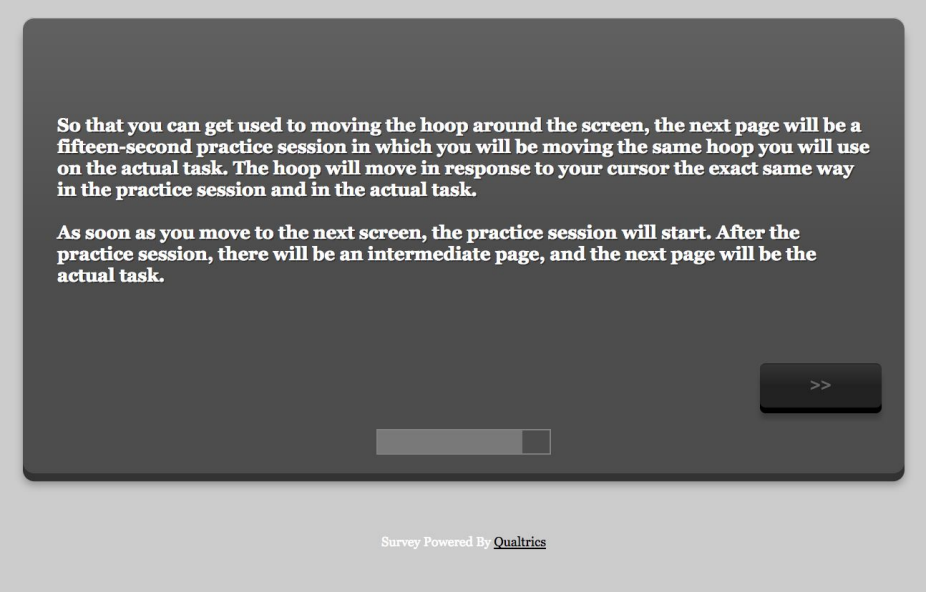
In the third and final investment scenario, your goal will be to keep a hoop around a moving dot for as much of 1 minutes as you can.

Previously, your partner did an exercise in which they moved a dot which followed their cursor on-screen for 1 minutes. We recorded the movements of this dot, and these exact movements will be the movements of the dot you will be attempting to keep inside of a hoop. The other participant knew that these movements would be recorded for the purposes of testing coordination with another individual, and that the rewards associated with this task would depend on how well a second participant (you) would be able to "sync up" with their movements, but a certain minimum amount of movement was required of them so as to not make the task too easy. The hoop will follow your cursor on the screen.

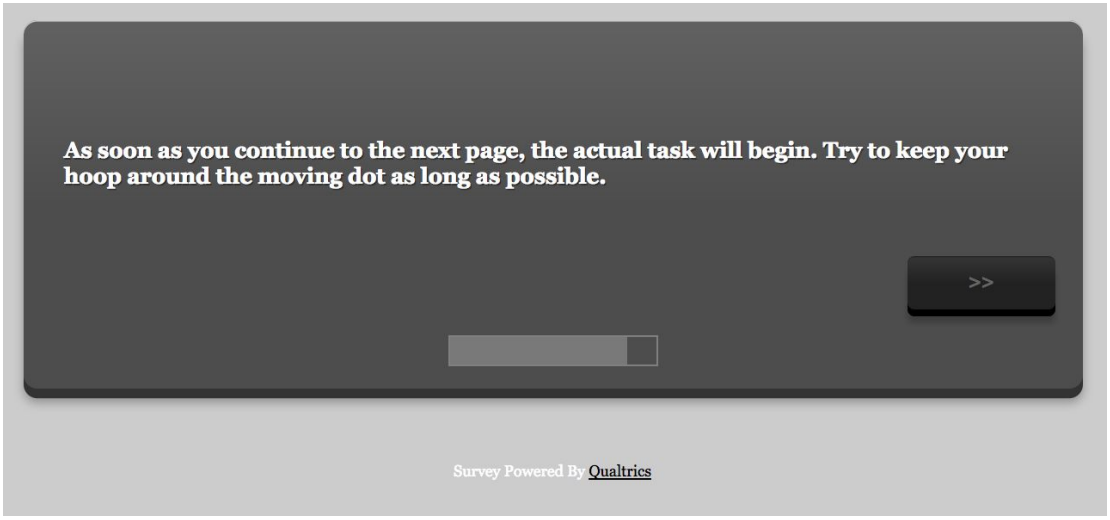
>>

We will measure the amount of time out of the minute you are able to keep your hoop surrounding the moving dot. All other groups are performing this same task, and your group's performance will be compared to the performance of these other groups. Again, performance here is simply how long the later participant (you in this case) is able to keep the hoop they control around the dot whose movements mimic the movements of the first participant of the group.

>>


So that you can get used to moving the hoop around the screen, the next page will be a fifteen-second practice session in which you will be moving the same hoop you will use on the actual task. The hoop will move in response to your cursor the exact same way in the practice session and in the actual task.
As soon as you move to the next screen, the practice session will start. After the practice session, there will be an intermediate page, and the next page will be the actual task.
>>
Survey Powered By Qualtrics


Time Remaining: 00:09
>>
Survey Powered By Qualtrics


As soon as you continue to the next page, the actual task will begin. Try to keep your hoop around the moving dot as long as possible.
>>
Survey Powered By Qualtrics


Time Remaining: 00:48
>>
Survey Powered By Qualtrics

APPENDIX B: HTML CODE

```
<div id="timer_ml">Time Remaining: <span id="time_ml">01:00</span></div>

<div id="message_ml"></div>

<div id="frame_ml" style="width: 700px; height: 500px; border:1px solid black;">

<div class="dot_ml" style="border-radius: 50%;
  background: black;
  width: 10px;
  height: 10px;
  position: fixed;
  top: 0;
  left: 0;">
</div>
<div class="loop_ml" style="width: 80px; height: 80px; border-style: solid;
   border-color: #ff0000; border-radius: 40px; position: fixed"></div>

</div>
```

APPENDIX C: JAVASCRIPT CODE

```
var csvArray = [];
var results = [];
var sum = 1;
var startTime = Date.now();
var overlap = false;
var timers = [];
var isOnDiv = true;

var offsets = -1;
var xPositions = [];
var yPositions =[];
var timestamps = [];
var timeout_ml = null;

$(document).mousemove(function(e){
	if(Date.now() - startTime > 1000){

		if (timeout_ml !== null) {
			clearTimeout(timeout_ml);
		}

		timeout_ml = setTimeout(function() {
			$('.loop_ml').css('border', 'solid red');
			if(overlap == true){
				end = timestamp;

				if((end-start) != null){
					sum += (end-start);
				}


			}
			overlap = false;

		}, 100);

		var loopDiameter_ml = $('.loop_ml').outerWidth(true);
		if(offsets === -1){
		 offsets = document.getElementById('frame_ml').getBoundingClientRect();
//problem statement
```

```
                }
                var withinLowerBound_ml = (e.clientX < (offsets.right - loopDiameter_ml/2))
&&(e.clientY < (offsets.bottom - loopDiameter_ml/2));
                var withinUpperBound_ml = (e.clientX > (offsets.left + loopDiameter_ml/2))
&&(e.clientY > (offsets.top + loopDiameter_ml/2));
                if(isOnDiv && withinLowerBound_ml && withinUpperBound_ml){

                //move loop
                //$('.loop_ml').css({left:e.pageX, top:e.pageY});
                $('.loop_ml').css({left:e.pageX-(loopDiameter_ml/2),
top:e.pageY-(loopDiameter_ml/2) });

                var timestamp =  Date.now() - startTime;
                //record movements
                results.push({
                        time: timestamp,
                        x: e.pageX,
                        y: e.pageY,
                        bool: overlap
                });

                if(csvArray.length == 0){
                        var titles = ["time", "x", "y", "bool"];
                        csvArray.push(titles);
                }
                var temp = [timestamp, e.pageX, e.pageY, overlap];
                csvArray.push(temp);

                if(collision($('.dot_ml'), $('.loop_ml'))){
                        $('.loop_ml').css('border', 'solid green');

                        if(overlap == false){
                                start = timestamp;
                        }

                        overlap = true;
                }else{

                        $('.loop_ml').css('border', 'solid red');
                        if(overlap == true){
                                end = timestamp;

                                if((end-start) != null){
```

```
                                        sum += (end-start);
                        //document.getElementById('message_ml').innerHTML =
JSON.stringify(sum);
                }

        }
        overlap = false;
      }
    }

 }
});

$(document).ready(function(){

        csvArray.push(["time", "x", "y", "bool"]);
        var $replay = $('.dot_ml'),
        pos, i = 0,
        len = move.length,
        t;

        (function anim() {
                pos = move[i];
                var x = pos.y + offsets.top;
                var y = pos.x + offsets.left - 20;


                $replay.css({

                        top: x,
                        left: y
                });

                i++;

                if (i === len) {
                        clearTimeout(t);
                } else {
                        t = setTimeout(anim, 10);
                }
        })()

        var oneMinute = 60 * 1,
```

```
	display = $('#time_ml');
	startTimer(oneMinute, display);

	$('#frame_ml').mouseenter(function(){isOnDiv=true;});
	$('#frame_ml').mouseleave(function(){isOnDiv=false;});
});

function collision($div1, $div2) {
	var x1 = $div1.offset().left;
	var y1 = $div1.offset().top;
	var h1 = $div1.outerHeight(true);
	var w1 = $div1.outerWidth(true);
	var b1 = y1 + h1;
	var r1 = x1 + w1;
	var x2 = $div2.offset().left;
	var y2 = $div2.offset().top;
	var h2 = $div2.outerHeight(true);
	var w2 = $div2.outerWidth(true);
	var b2 = y2 + h2;
	var r2 = x2 + w2;

	if (b1 < y2 || y1 > b2 || r1 < x2 || x1 > r2) return false;
	return true;
}

function startTimer(duration, display) {
	var timer = duration, minutes, seconds;
	var t = setInterval(function () {
		minutes = parseInt(timer / 60, 10);
		seconds = parseInt(timer % 60, 10);

		minutes = minutes < 10 ? "0" + minutes : minutes;
		seconds = seconds < 10 ? "0" + seconds : seconds;

		display.text(minutes + ":" + seconds);

		if (--timer < 0) {
			sum += 1;


Qualtrics.SurveyEngine.setEmbeddedData("results_ml",JSON.stringify(results));
Qualtrics.SurveyEngine.setEmbeddedData("sum_ml",JSON.stringify(sum));
```

```
                        var csvContent = "data:text/csv;charset=utf-8,";
                        csvArray.forEach(function(infoArray, index){
                                dataString = infoArray.join(",");
                                csvContent += dataString + "\n";
                        });
                        var encodedUri = encodeURI(csvContent);
                        window.open(encodedUri);

                        document.getElementById('message_ml').innerHTML ="Press >> to
Continue";
                        document.getElementById('timer_ml').innerHTML = "";
                        $('.dot_ml').remove();
                        $('.loop_ml').remove();
                        for (var i = 0; i < timers.length; i++){
                                clearInterval(timers[i]);
                        }
                }
        }, 1000);
        timers.push(t);
}
});
```

References

Kahneman, Daniel; Knetsch, Jack L.; Thaler, Richard H. (1986-01-01). "Fairness and the Assumptions of Economics". *The Journal of Business*. 59 (4): S285–S300

Berg, Joyce, John Dickhaut, Kevin McCabe. “Trust, Reciprocity, and Social History.” Games and Economic Behavior 10, (1995): 123, 122-142

Russell Cooper: *Coordination Games*, Cambridge: Cambridge University Press, 1998