

# RESEARCH ETHICS BOARDS

# APPLICATION FORM

**Prospective Research**

This form should only be used if new data will be collected. For research involving only secondary use of existing information (such as health records, student records, survey data or biological materials), use the *REB Application Form – Secondary Use of Information for Research.*

This form should be completed using the [*Guidance for Submitting an Application for Research Ethics Review*](https://cdn.dal.ca/content/dam/dalhousie/pdf/research-services/REB/Dal%20REB%20Application%20Instructions%20-%20Prospective%20Research%20%20v2021-02.pdf).

## SECTION 1. ADMINISTRATIVE INFORMATION [File No: office only]

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| Indicate the preferred Research Ethics Board to review this research:  [ ] Health Sciences OR [ X ] Social Sciences and Humanities |

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| **Project Title:**  Skills Training and Transfer between Virtual Reality and Real Life. |

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| **1.1** **Research team information** | | | | | | | |
| Lead researcher  (at Dalhousie) | Name | **Kissinger Sunday** | | | | | |
| Email (@dal) | **Kissinger.sunday@dal.ca** | | Phone | | | **9022407670** |
| Banner # | **B00937693** | | Academic Unit | | | **Faculty of Computer Science** |
| Co-investigator names, affiliations, and email addresses | Mayra Donaji Barrera Machuca, Dalhousie University, [mbarrera@dal.ca](mailto:mbarrera@dal.ca)  Anil Ufuk Batmaz, Concordia University, [ufuk.batmaz@concordia.ca](mailto:ufuk.batmaz@concordia.ca)  Junwei Sun, Simon Fraser University, [junwei.s@yahoo.com](mailto:junwei.s@yahoo.com)  Yiwei Li, University of Western Ontario, [yli922@uwo.ca](mailto:yli922@uwo.ca)  Heather Neyedli, Dalhousie University, [hneyedli@dal.ca](mailto:hneyedli@dal.ca)  Rina Wehbe, Dalhousie University, rina.wehbe@dal.ca | | | | | | |
| Contact person for this submission (if not lead researcher) | Name | n/a | | | | | |
| Email | n/a | | | Phone | n/a | |
| Study start date | 2023 / 06 / 01 | | Study end date | | 2023 / 09/ 31 | | |

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| **1.2** **For student submissions** (including medical residents and postdoctoral fellows) | | | |
| Degree program | PhD Computer Science | | |
| Supervisor name and department | Mayra Donaji Barrera Machuca | | |
| Supervisor Email (@dal) | mbarrera@dal.ca | Phone | 778-223-7753 |
| Department/unit ethics review (if applicable). **Undergraduate minimal risk research only**. | | | |
| Attestation: [ n/a ] I am responsible for the unit-level research ethics review of this project and it has been approved.  Authorizing name: n/a  Date: n/a | | | |

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| **1.3** **Other reviews** | | | | |
| Other ethics review (if any) for this research | | Where? | n/a | |
| Status? | n/a | |
| Scholarly/scientific peer review (if any) | n/a | | | |
| Is this a variation on, or extension of, a previously approved Dal REB submission? | | | | [n/a] No  [x] Yes Dal REB file #\_\_2022-6175 \_\_\_ |
| **~~If yes~~**~~, describe which components of the current submission are the same as the previously approved submission (list section numbers), and which components are different from the previously approved submission (list section numbers). You may also use highlighting to clearly indicate revised text.~~ | | | | |

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| **1.4** **Funding**  [ ] Not Applicable | | |
| Funding (list on consent form) | Agency | Dalhousie |
| Award Number | n/a |
| Institution where funds are/will be held | [ X ] Dalhousie University  [ ] Other: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| Was a Dal release of funds agreement issued for this award? | | [ ] Yes Date of RoF Agreement: |

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| **1.5 Attestation(s).** The appropriate boxes *must* be checked for the submission to be accepted by the REB |
| **[ X ]** I am the **lead researcher** (at Dalhousie) named in section 1.1. I agree to conduct this research following the principles of the Tri-Council Policy Statement *Ethical Conduct for Research Involving Humans* ([TCPS](http://www.pre.ethics.gc.ca/eng/policy-politique_tcps2-eptc2_2018.html)) and consistent with the University [*Policy on the Ethical Conduct of Research Involving Humans*](http://www.dal.ca/dept/university_secretariat/policies/human-rights---equity/ethical-conduct-of-research-involving-humans-policy.html).  I have completed the TCPS Course on Research Ethics ([CORE](http://tcps2core.ca/welcome)) online tutorial.  [ X ] Yes [ ] No  For Supervisors (of student / learner research projects):  **[X]** I am the **supervisor** named in section 1.2. I have reviewed this submission, including the scholarly merit of the research, and believe it is sound and appropriate. I take responsibility for ensuring this research is conducted following the principles of the [TCPS](http://www.pre.ethics.gc.ca/eng/policy-politique_tcps2-eptc2_2018.html) and University [Policy](http://www.dal.ca/dept/university_secretariat/policies/human-rights---equity/ethical-conduct-of-research-involving-humans-policy.html).  I have completed the TCPS Course on Research Ethics ([CORE](http://tcps2core.ca/welcome)) online tutorial.  [X] Yes [ ] No |

## SECTION 2. PROJECT DESCRIPTION

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| **2.1 Lay summary** |
| 2.1.1 In **plain language**, describe the rationale, purpose, study population and methods to be used. Include a summary of background information or literature to contextualize the study. What new knowledge, or public or scientific benefit is anticipated? [maximum 500 words]  The increase in virtual reality (VR) popularity has made people play VR games that emulate real-life sports in VR, like table tennis and golf. An earlier study [6] shows that VR training generally improves real-life performance. While this generic observation holds valid, more in-depth studies are needed to further understand the skill transfer between VR and real life among different skill levels and sports. In particular, no study currently evaluates skills training and transfer between VR and real life (RL), including measuring the physical exertion of VR table tennis sports. Our study will fill this gap by training players in table tennis skills under controlled conditions. It will further evaluate skills transfer between the VR and RL settings, including identifying specific muscles trained during the process and measuring the physical exertion of players. We focus on this sport as the required skills use eye-hand coordination, foot movement, and accuracy, which test the limits of current VR technologies. We will also take advantage of one of the most popular and realistic VR games called Eleven Table Tennis (ETT, <https://elevenvr.com/en/>) to conduct the experiment with VR table tennis players.  To achieve this target, we will conduct two user studies, one where we train novice players in VR or RL using the same methods. These novice players have no experience playing table tennis in either environment. In both user studies, we will train our participants following the same program and with the same coach, with the only difference being the environment used. Both studies will involve pre and post-comparison in VR and RL, and we will evaluate skills transfer and performance between these environments. In addition, we will measure the physical exertion of the players using a heart rate monitor (E4 Empatica) to determine if VR and RL training are similar regarding physical activity. We will also identify the specific muscles trained in both environments using Mobi6 to see if they are similar or different. For this study, we will recruit participants from the University community.  The study aims to learn whether skills trained in VR can be transferred to RL, and skills trained in RL can be transferred to VR. It also aims to identify differences in muscles trained and physical activity. We would like to provide some guidelines on how to design VR (sports) games to improve skill training, transfer and physical activity between VR and real-life. Finally, we expect to publish our results at top HCI conferences like ACM CHI Play or ACM CHI.  [ ] This is a pilot study.  [ X] This is a fully developed study. |
| 2.1.2 Phased review. If a phased review is being requested, describe why this is appropriate for this study, and which phase(s) are included for approval in this application. Refer to the [guidance document](https://cdn.dal.ca/content/dam/dalhousie/pdf/research-services/REB/Dal%20REB%20Application%20Instructions%20-%20Prospective%20Research%20%20v2021-02.pdf) before requesting a phased review.  [X] Not applicable |

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| **2.2** **Research question** |
| State the research question(s) or research objective(s).  In this study, we will pursue the following research questions:  ***1. Can specific table tennis skill transfer between VR and RL and between RL and VR?***  ***2. Does playing table tennis in a VR environment provide a similar level of physical activity to RL?***  **3. What specific muscles are trained while playing table tennis in VR and RL?** |

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| **2.3** **Recruitment** |
| 2.3.1 Identify the study population. Describe and justify any inclusion / exclusion criteria. Also describe how many participants are needed and how this was determined.  The study population is people interested in learning to play table tennis. They should be able to play table tennis in both environments (VR and RL). We will run two different user studies, one for players training in VR and the other for players training in RL. To determine the required sample size for this study, we consulted Schoenfeld's statistical methodology [9]. The calculation took into account continuous scales, a parallel design, an 80% power test, and a 5% significance level in a single-tailed test. The estimated sample size required for both studies is 24 participants, with a distribution of 12 participants in each study. This sample size aligns with previous research conducted in this field [10]. In anticipation of an expected dropout rate of around 15%, our goal is to recruit a minimum of 28 participants, with 14 participants assigned to each study. It is important to note that participants who take part in one study will not be eligible to participate in the other study, as they would have already acquired the skills we aim to teach them.  The inclusion criteria to participate will be people that have no prior experience or they have played table tennis no more than once a month in the past five years and have not had any formal training as a novice. In the recruitment material, we will specifically request this type of participant, and we will also assess their skills during a pretest experiment. To achieve our goal and make efficient use of participants' time, the coach will quantitatively assess each participant during the pretest by evaluating their performance in serving and returning a ball. Participants who score above 60% on both serving and returning a ball will be excluded from the study, as they are deemed to have significant experience in the sport. We will apply the same evaluation criteria for both the virtual reality and real-life studies.  Before the training sessions, we will inform participants that they will be excluded from the study at any time if they play table tennis outside the training regimen in order not to affect the result of the study. Other exclusion criteria in this study are defined to overcome practical issues related to the opportunity to participate in the study itself such as:   * Players who have accessibility needs that cannot be met through the user interface and VR HMDs used to run the study. * Players who cannot attend the study settings in person. * Players that have experienced motion sickness or other issues when using VR HMDs in the past.   Participants will be informed that participation in the study requires them to attend the lab in person and to wear a VR HMD on the ad about the user study |
| 2.3.2 Describe recruitment plans and append recruitment instruments. Describe who will be doing the recruitment and what actions they will take, including any screening procedures.  Recruitment will take place within the Dalhousie Campus in Halifax and will aim to recruit members of the university community interested in playing table tennis and becoming an expert. The recruitment will be conducted by the lead researcher (Kissinger Sunday) during the Summer 23 and Fall 24 terms. Kissinger will be responsible for posting the advertisement on the notice board around Dalhousie Campus, and the FCS HCI cluster teams.  Once someone shows interest in participating in the user study, they will be informed of the location of the user study and asked about their experience playing table tennis and if they have any limitations that prevent them from playing. If they answer both questions negatively, we will send them the consent form and book a time for the first session. The answer to these questions will not be recorded, and if someone that shows interest is screened out, we will delete all communication with them.  Aside from obtaining verbal/written information about their experience, we will conduct additional assessments during the first session. We want only novice players who have no prior experience or who have played table tennis no more than once a month in the past five years and have not had any formal training to participate in the study. We will have participants self-report their playing time and experience, including professional training. Moreover, in the first session, we will evaluate their skill level to ensure that we do not recruit individuals who are already highly proficient in table tennis. To achieve this goal and to ensure the efficient use of participants' time, the coach will conduct a quantitative assessment of each participant during the pre-test, evaluating their performance in serving and returning a ball. Participants who score above 60% on both serving and returning a ball will be excluded from the study, as these individuals are considered to have significant experience in the sport. We will use the same evaluation schemes for virtual reality and real-life studies. If participants are screened out due to table tennis experience, they will be informed that they cannot do the user study. However, participants will still be offered the opportunity to play table tennis without recording their data. They will also be paid for participating in this first session.  Another exclusion criterion is if participants do not complete the full training consisting of 5 sessions and the post-evaluation. In such cases, participants will be considered as having dropped out of the study, and their data will be removed. |
| 2.3.3 If you require permission, cooperation, or participation from a community, organization or company to recruit your participants, describe the agreement obtained from the relevant group(s). Attach correspondence indicating their cooperation and/or support (required). Describe any other community consent or support needed to conduct this research. (If the research involves Indigenous communities’ complete section 2.11).  [ X ] Not applicable |

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| **2.4** **Informed consent process** |
| 2.4.1 Describe the informed consent process:  A) How, when and by whom will the study information be conveyed to prospective participants? How will the researcher ensure prospective participants are fully informed?    For our study, the advertisement outlines all risks associated with the research, as well as the role of the person posting the advertisement. A description of the advertisement for the study is attached to this application.  We will begin by sending an email containing both the recruitment advert and the consent form which includes all the necessary information about the study. If a participant agrees to participate, they will be required to come to the lab in person to fill out the form. Participants who complete the consent process will receive comprehensive information about the study, including any risks and benefits associated with participation, by reading the consent form. The consent form will provide details such as a layman's description of the study and its purpose, contact information, potential risks and benefits of participation, as well as the right to withdraw without facing any penalties.  B) Describe how consent will be documented (e.g., written signature, audio-recorded, etc).  Participants will need to visit the lab in person to complete the consent process before proceeding with the pretest experiment. In the initial phase, we will send an email containing both the recruitment advertisement and the consent form. This email will clearly communicate the study's requirements and expectations, including eligibility criteria and time commitment. Interested participants should send an email to the Principal Investigator to express their interest in the study. Subsequently, we will schedule a session where participants will sign the consent form in the lab and complete the screening questionnaires. If they remain eligible, we will then proceed with collecting data on their table tennis baseline skills.  The instructions have been carefully designed to ensure that participants are well-informed about the research, can ask questions and receive answers, and understand that their participation is voluntary. Participants may also request a printed version of the consent form to take with them. The consent forms will be securely stored under the supervision of the supervisor, Dr. Mayra Barrera Machuca, and will not be kept by the student researcher.  [ X ] Append copies of all consent information that will be used (e.g. written consent document, oral consent script, assent document/script, etc).  *Note: If the research will involve third party consent (with or without participant assent), and/or ongoing consent, ensure these are described above.* |
| 2.4.2 Discuss how participants will be given the opportunity to withdraw their participation (and/or their data) and any time (or content) limitations on this. If participants will not have opportunity to withdraw their participation and/or their data explain why.  Participants have the right to withdraw from voluntary participation without any penalties incurred for not completing the study (see also 2.5.3 Compensation).  Participants who withdraw during the user study are eligible to participate in these activities (play VR or RL table tennis), but their data will be excluded from further analysis. However, once the participant finishes the study, they will no longer be able to withdraw their data, as we will store de-identified data. We hope to train participants for 5 sessions which are consistent with past work in this area [9] after which the participant will show up for a post-assessment where we will measure skills transfer in both environments. However, if the participant fails to be available for the post-test study after the training period has elapsed, we will exclude such participants from the study as we will consider them to have dropped out of the experiment, and their data will be deleted accordingly. This includes data collected while using the training application. We will inform participants at the beginning of the first session, and at the end of the fifth session. |
| 2.4.3 If an alteration/exception to the requirement to seek prior informed consent is sought, address the criteria in TCPS article [3.7A](http://www.pre.ethics.gc.ca/eng/tcps2-eptc2_2018_chapter3-chapitre3.html#b). If the alteration involves deception or nondisclosure, also complete section 2.4.4.  [ X ] Not applicable |
| 2.4.4 Describe and justify any use of deception or nondisclosure and explain how participants will be debriefed.  [ X ] Not applicable |

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| **2.5** **Methods, data collection and analysis** |
| 2.5.1  A) Where will the research be conducted?  The research will be conducted inside the FCS HCI cluster installations, in the VR and Graphics Lab.  B) What will participants be asked to do?  First, members of the university community will read the advertisement posted around campus and choose whether (1) to participate in the study, or (2) not. If they decide to participate, we will set a time and date to do the user study. We will recruit participants starting from the date the advertisement is posted until we get all the required participants for each study. We will first recruit and run study 1 (VR), and after successful completion we will run study 2 (RL).  Our project involves two user studies, in each study participants will do the same tasks but the difference is the environment (RL and VR). We want only novice players to participate in the study. We will have participants self-report their playing time and experience, including professional training. Moreover, in the first session, we will evaluate their skill level to ensure that we do not recruit individuals who are already highly proficient in table tennis. To achieve this goal and to ensure the efficient use of participants' time, the coach will conduct a quantitative assessment of each participant during the pre-test, evaluating their performance in serving and returning a ball. Participants who score above 60% on both serving and returning a ball will be excluded from the study, as these individuals are considered to have significant experience in the sport. We will use the same evaluation schemes for virtual reality and real-life studies. The independent coach will be responsible for serving/volleying to the participants and will assess other metrics such as speed of return, accuracy of ball placement, footwork, and ability to serve.  After the pre-test is completed, participants will undergo training where a coach will train participants on these skills, and we will evaluate how these skills transfer between VR and real life in a post-test. We will also evaluate physical exertion of the VR participants using a heart rate monitor (E4 Empatica) to learn whether playing in VR provides a similar level of physical exertion compared to playing in RL. Furthermore, we will identify the part of the human muscle that is trained in both situations using Mobi6. However, we plan to conduct a learning experiment, with a pre- and post-study to compare the user performance change using metrics such as speed, strength, consistency, technique, and coordination among the participants. Due to the training session (5) and the pre- and post-study comparison, participants will need to visit the lab seven times.The RL and VR evaluation will happen in the same space. After the experiments, they will have to fill out a post-study questionnaire about their experiences.  After their participation, participants will be paid CAD 63 for their time, which will be paid by: Dalhousie Belong Fellowship, funding Number: R35819 (See funding section).  C) What data will be collected using what research instruments? *(Note that privacy and confidentiality of data will be covered in section 2.6)*  We will measure the training of specific skills in VR, and skill transfers between VR and real life. The data sources in this study include tracking data, video, heart rate data, table tennis data, and questionnaires. The tracking data will also include tracking data of the ball, the controllers, and the players that will allow us to measure the performance, including providing data on muscle. It will also allow us to identify the actions, e.g., how the participants move, and what they do while playing. The heart rate data will allow us to measure physical exertion. The table tennis data will allow us to measure the player’s performance, e.g., points, serves returned, etc. The questionnaires will include demographic data, and self-reported data using standardized questionnaires about motion sickness [4], engagement [1, 5], burnout [7], immersion [2, 3, 8], percieved rate of physical exertion [11] and International physical activity questionnaire [13].  D) How much of the participant’s time will participation in the study require?  Both studies will consist of various training sessions (7 sessions). We foresee participants to go to the lab two times so we can record their pre and post training performance. These visits will take approx. 60 min training and 80 min pre-posttest (see Table 1). Between the visits, participants will be trained by a coach either in VR or RL.    Table 1: Time distribution between the sessions   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | **Session 1** | **Session 2** | **Session 3** | **Session 4** | **Session 5** | **Session 6** | **Session 7** | | Pre- Test | Training #1 | Training #2 | Training #3 | Training #4 | Training #5 | Post-Test | | 20min survey | 1 hour | 1 hour | 1 hour | 1 hour | 1 hour | 20min survey | | 30min VR |  |  |  |  |  | 30min VR | | 30min RL |  |  |  |  |  | 30min RL | | 80min | 5 hours | | | | | 80min |   [ X ] Append copies of all research instruments (questionnaires, focus group questions, standardized measures, etc)  ~~[ n/a ] This is a clinical trial (physical or mental health intervention) – ensure section 2.12 is completed~~ |
| 2.5.2 Briefly describe the data analysis plan. Indicate how the proposed data analyses address the study’s primary objectives or research questions.  We will achieve our first research question (***Can specific table tennis skill transfer between VR and RL and between RL and VR?***) by analyzing the experimental data collected in both environments using motion capture, video & tracking data. The two researchers in the team (Kissinger Sunday & Yiwei Li) with table tennis experience will be involved in scoring participants' skills independently based on the scoring criteria outlined in Appendix D (Scoring Criteria). Afterwards, the average score will be computed based on the scores assigned by the researchers for each skill. We will use the scores to identify skills transferred between the environments.  Statistical tests such as Analysis of Covariance (ANCOVA) or the non-parametric version (Quade’s) will be used to determine if there are significant improvements in skills. In this instance, the pretest scores serve as the covariate which is included to provide a more precise estimate of the intervention and provide adequate control for confounding variables.  For the second research question (***Does playing table tennis in a VR environment provide a similar level of physical activity to RL?***) We will achieve this by analyzing the collected heart rate data of the participants including their resting heart rate before and after the study throughout the sessions. This will happen in the last session where participants will play in both environments. Statistical tests such as Analysis of Covariance (ANCOVA) or the non-parametric version (Quade’s) will be used to determine if there are significant differences in physical exertion between the two groups (VR and RL). We will use the resting heart rate as the covariate to increase the statistical power and improve the precision of the estimates.  For the third research question (**What specific muscles are trained while playing table tennis in VR and RL?**) We will analyze the perception of the participants on muscle improvement using an open-ended feedback instrument, and the tracking data using Mobi6. In addition, we will perform statistical tests such as independent samples t-test or its non-parametric equivalent (Mann-Whitney U test) to determine if there are significant differences between the two groups (VR and RL). Questionnaires will provide self-reported data for perceived rate of physical exertion, immersion, motion sickness, engagement and burnout and will be analyzed using an independent samples t-test or its non-parametric equivalent (Mann-Whitney U test). |
| 2.5.3 Describe any compensation that will be given to participants and how this will be handled for participants who do not complete the study. Discuss any expenses participants are likely to incur and whether/how these will be reimbursed.  Participants will receive 9 CAD after each experiment before leaving the lab. This incentive aims to ensure that participants remain engaged throughout the study and maintain contact with the research team. At the end of the 7 sessions (Table 1), participants will receive a total of 9 CAD per day \* 7 days = 63 CAD as compensation for their participation. The payment will be in cash to respect the participant’s anonymity.  The HCI group already has a table tennis table, VR HMDs devices, heart rate monitor (E4 Empatica) and all the equipment needed to run this user study, so participants don’t need to do any expenses to participate in the user study. |

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| **2.6** **Privacy and confidentiality** |
| 2.6.1  A) Describe who will have knowledge of participants’ identities.  The researcher running the user study (Kissinger Sunday) will know the participant's identity, as they will be with them in person during the user study. This researcher won’t have any influence or authority over the participants, e.g., by their teacher or supervisor. This researcher is responsible for storing, directly and indirectly, identifying information from the consent form and demographic survey. The demographic survey and the data collected from the user study won’t be linked in any way to the consent form, as a way to prevent the re-linking of both information. This includes providing a random identifier to each participant.  B) Describe the level of identifiability of the study data (anonymous, anonymized, de-identified/coded, identifying) (see [TCPS Chapter 5A – types of information](http://www.pre.ethics.gc.ca/eng/tcps2-eptc2_2018_chapter5-chapitre5.html#a) for definitions).  Given the presence of video recordings in this study, it is important to acknowledge that the data may not be considered entirely "anonymized". Therefore, we have we will take the following measures to maintain the privacy and confidentiality of the participants:   1. Blurring identifying features: We will apply techniques to blur or mask any identifying features present in the video recordings. 2. Participant code assignment: Instead of using participants' real names, we will assign unique codes or identifiers to each participant. These codes will be used to reference individuals in the recordings and will not be kept allowing future re-linkage. 3. Restricted access: Access to the video recordings will be limited to the researchers involved in the study. Strict regulations will be implemented to control and monitor access to the data. 4. Secure storage: The video recordings will be stored in a secure location, such as password-protected servers. These measures will ensure that only authorized individuals can access the data.   It is important to note that participants will be clearly informed about the use of video recordings, and their informed consent will be obtained before any recording takes place. Additionally, we will provide a detailed explanation of how the recordings will be handled, de-identified, and stored to ensure transparency and maintain the privacy and confidentiality of participants.  C) Specify which members of the research team (or others) will have access to participants’ data and for what purpose.  The primary investigator Kissinger Sunday will have access to the data for analysis and write the paper. My supervisor Dr. Mayra Donaji Barrera Machuca and other co-investigators Dr. Anil Ufuk Batmaz, Junwei Sun will also have access to the data for analysis and feedback. The following co-investigator will have access to aggregate findings resulting from the data analysis to provide feedback and write the paper.   * Yiwei Li, University of Western Ontario, [yli922@uwo.ca](mailto:yli922@uwo.ca) * Heather Neyedli, Dalhousie University, [hneyedli@dal.ca](mailto:hneyedli@dal.ca) * Rina Wehbe, rina.wehbe@dal.ca   D) Describe measures to ensure privacy and confidentiality of study documents and participant data during the data collection and analysis phase. *[Note that plans for long term storage will be covered in 2.6.2*]   * Address: handling of documents/data during data collection; transportation or transfer of documents/data; storage of documents/data (during the study). * If a key-code will be maintained, describe how it will be kept secure. * For electronic data, describe electronic data security measures, including file encryption and/or password protection [as applicable](https://cdn.dal.ca/content/dam/dalhousie/pdf/research-services/REB/Protecting%20Electronically%20Stored%20Personally%20Identifiable%20Research%20Data.pdf). * For hard copy documents, describe physical security measures (specify location).   Data collected in this study will be first collected and stored for a limited time duration in a private SharePoint list, the Dalhousie university institutional cloud storage platform. All data stored in SharePoint, similar to OneDrive, has multiple layers of security (BitLocker disk-level encryption and per-file encryption) and is stored on institutional servers. Access to the SharePoint list requires proper login credentials, which can be managed by the lead researcher at both the level of the list and fields within the list.  ~~[ n/a ] This research involves personal health records (ensure section 2.13 is completed)~~ |
| 2.6.2 Describe plans for data retention and long-term storage (i.e. how long data will be retained, in what form and where). Will the data eventually be destroyed or irreversibly anonymized? If so, what procedures will be used for this? Discuss any plans for future use of the data or materials beyond the study currently being reviewed.  The 3-2-1 backup rule will be followed for data storage and backup. Team members will transfer the anonymous and anonymized data stored in the Dalhousie University's institutional SharePoint list, secure cloud-based storage developed by Microsoft, onto two encrypted external storage hard drives. SharePoint can be easily accessed and limited to the researcher leading the consent and data collection efforts. One of the external storage hard drives will be stored offsite.  [ ] This research will be deposited in a data repository (ensure section 2.14 is completed) |
| 2.6.3  Describe if/how participant confidentiality will be protected when research results are reported:  A) For quantitative results - In what form will study data be disseminated?  [ X ] Only aggregate data will be presented  [ ] Individual de-identified, anonymized or anonymous data will be presented  [ ] Other. If “other”, briefly describe dissemination plans with regard to identifiability of data.  [ ] Not applicable, only qualitative data will be presented  B) For qualitative results - Will identifiable data be used in research presentations/publications? If participants will be quoted, address consent for this and indicate whether quotes will be identifiable or attributed.  [ X ] Not applicable, only quantitative data will be presented |
| 2.6.4 Address any limits on confidentiality, such as a legal duty to report abuse or neglect of a [child](https://novascotia.ca/coms/families/changestoCFSA/Duty-to-Report.pdf) or [adult in need of protection](https://nslegislature.ca/sites/default/files/legc/statutes/adult%20protection.pdf), and how these will be handled. Ensure these are clear in the consent documents. (See the [guidance document](https://cdn.dal.ca/content/dam/dalhousie/pdf/research-services/REB/Dal%20REB%20Application%20Instructions%20-%20Prospective%20Research%20%20v2021-02.pdf) for more information on legal duties and professional codes of ethics).  [ X ] Not applicable |
| 2.6.5 Will any information that may reasonably be expected to identify an individual (alone or in combination with other available information) be accessible outside Canada? And/or, will you be using any electronic tool (e.g. survey company, software, data repository) to help you collect, manage, store, share, or analyze personally identifiable data that makes the data accessible from outside Canada?  [ X ] No  [ ] Yes. If yes, refer to the University [*Policy for the Protection of Personal Information from Access Outside Canada*](http://www.dal.ca/dept/university_secretariat/policies/governance/protection-of-personal-information-policy-.html), and describe how you comply with the policy (such as securing participant consent and/or securing approval from the Vice President Research and Innovation). |

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| **2.7 Risk and benefit analysis** |
| 2.7.1 Discuss what risks or discomforts are anticipated for participants, how likely risks are and how risks will be mitigated. Address any particular ethical vulnerability of your study population. Risks to privacy from use of identifying information should be addressed. If applicable, address third party or community risk. (If the research involves Indigenous communities also complete section 2.11)  We do not foresee any major risks for the participants. Physical risks include fatigue brought about by playing table tennis in VR. We will ask participants to come to the lab and conduct the research and also monitor their play in real life with the help of an independent coach. Physiological risk includes loss of balance, motion sickness and hitting the upper limbs during VR gameplay. We will have an empty open space for students to do the user study, to prevent any injury. Since participants will not always rotate their upper body, we do not anticipate any motion sickness, but the experimenter will ask users to take a rest if they feel exhausted during the VR and RL experience. We will also give participants a clear space to move their limbs freely and not hit the objects in the environment. Psychological risks include negative affective states such as boredom, anxiety, frustration, and loss of self-efficacy due to participants' appraisal of their performance in playing table tennis. These risks are no more serious than those induced by reflecting on their skills. In any case, participants may cease participation at any time without penalty.  To minimize the risk of loss of confidentiality, investigators won’t collect personal information during the process, including names and email. Also, only aggregate findings are reported regarding the group of participants. We will collect the de-identified data, so that collected data will not be traced back to the participants when they finish the post-study session. For the lab experiment, we will run the experiment in a closed lab, where only the researcher running the user study, the coach and the participant will be present, this will prevent other people from identifying participants identities. We will also leave time between participants to help them enter/exit the lab without seeing other participants. |
| 2.7.2 Identify any direct benefits of participation to participants (other than compensation), and any indirect benefits of the study (e.g. contribution to new knowledge).  Participants will benefit from gaining a better understanding of how they play table tennis and what skills they successfully trained and transferred between VR and RL. In addition, they will enjoy the benefit of exercise which leads to improved health and wellbeing through physiological measures such as heart rate. They will also benefit from knowing they are helping to know more about the table tennis community. For instance, the insights gained can be utilized by table tennis coaches, athletes, and training facilities to optimize training methodologies and improve the transfer of skills between virtual and real-life environments. This could potentially benefit individuals involved in table tennis at various levels, including recreational players, competitive athletes, and coaching professionals. The findings obtained from this research will also advance our understanding of the specific skills transferred between VR and RL. |

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| **2.8 Provision of results to participants and dissemination plans.** |
| 2.8.1 The TCPS encourages researchers to share study results with participants in appropriate formats. Describe your plans to share study results with participants and discuss the process and format.  The primary investigator will rely on a project website to disseminate all findings obtained in this study, including research articles, slide presentations, and videos. At the end of the recruitment online survey or user study, participants will be thanked for their participation and will be provided with the link to the website so that they may learn more about the research. |
| 2.8.2 If applicable, describe how participants will be informed of any material incidental findings – a discovery about a participant made in the course of research (screening or data collection) that is outside the objectives of the study, that has implications for participant welfare (health, psychological or social). See [TCPS Article 3.4](http://www.pre.ethics.gc.ca/eng/tcps2-eptc2_2018_chapter3-chapitre3.html) for more information.  [ X ] Not applicable |
| 2.8.3 Describe plans for dissemination of the research findings (e.g. conference presentations, journal articles, public lectures etc.).  The findings obtained from this research will be disseminated through conference presentations at both local (i.e., CHCCS/SCDHM Graphics Interface) and international venues (e.g., ACM CHI Play or ACM CHI). |

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| * 1. **Research Team** |
| 2.9.1 Describe the role and duties of all research team members (including students, RA’s and supervisors) in relation to the overall study.   * Kissinger Sunday: PhD of Computer Science student at Dalhousie University. He will help by designing the user study, running the experiment and the data analysis. * Dr. Mayra Donaji Barrera Machuca: Main supervisor of the primary investigator is responsible for study design and leading the analysis. * Dr. Anil Ufuk Batmaz: Research contribution: He communicates and coordinates the students who will prepare and run the experiment. * Junwei Sun: Research contribution: May assist with designing the materials and surveys, plus provide expertise when analyzing the data. * Yiwei Li: Research contribution: May assist with designing the materials and surveys, plus provide expertise when analyzing the data. * Heather Neyedli: Research contribution: She may assist with analyzing the data. * Rina Wehbe: Co-supervisor of the primary investigator is responsible for leading the analysis. |
| 2.9.2 Briefly identify any previous experience or special qualifications represented on the team relevant to the proposed study (e.g. professional or clinical expertise, research methods, experience with the study population, statistics expertise, etc.).   * Kissinger Sunday: He has experience doing qualitative and quantitative data analysis. He has also experience running experiments. * Barrera Machuca: She is a researcher focused on VR, especially on human performance. She has experience in running user studies, and data analysis. * Batmaz: He is a researcher focused on Virtual Reality and eye hand coordination training systems. He previously conducted quantitative and qualitative studies. He also has experience in running user studies and statistical analysis on sample data. * Sun: He is a researcher focused on input methods for VR, 3D pointing, and has experience running user studies and designing new VR applications. He is an amateur table tennis player and an experienced Eleven Table Tennis player. * Li: He is a researcher focused on Bioinformatics and Deep Learning. He is a semi-professional table tennis player and an experienced Eleven Table Tennis player. * Heather Neyedli: She is a researcher focused on sports science with extensive knowledge in gathering and analyzing health-related data. * Rina Wehbe: She is a researcher focused on games for health and with extensive experience in running user studies and data analysis. |

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| **2.10 Conflict of interest** |
| Describe whether any dual role or conflict of interest exists for any member of the research team in relation to potential study participants (e.g. TA, fellow student, teaching or clinical relationship), and/or study sponsors, and how this will be handled.  [ X ] Not applicable |

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| **2.11** **Research involving Indigenous peoples**  Consult TCPS [Articles 9.1 and 9.2](http://www.pre.ethics.gc.ca/eng/tcps2-eptc2_2018_chapter9-chapitre9.html) in determining whether this section is applicable to your research.  [ X ] Not applicable – go to 2.12 |
| ~~2.11.1 If the proposed research is expected to involve people who are Indigenous, describe the plan for community engagement (per TCPS Articles~~ [~~9.1 and 9.2~~](http://www.pre.ethics.gc.ca/eng/tcps2-eptc2_2018_chapter9-chapitre9.html#c)~~). If community engagement is not sought, explain why the research does not require it, referencing TCPS article 9.2.~~ |
| ~~2.11.2 State whether ethical approval has been or will be sought from~~ [~~Mi’kmaw Ethics Watch~~](https://www.cbu.ca/indigenous-affairs/mikmaw-ethics-watch/) ~~and if not, why the research does not fall under their purview. If the research falls under the purview of other Indigenous ethics groups, state whether ethical approval has been or will be sought.~~ |
| ~~2.11.3 Describe plans for returning results to the community and any intellectual property rights agreements negotiated with the community with regard to data ownership (see also 2.11.4 if applicable). Append applicable research agreements.~~ |
| ~~2.11.4 Does this research incorporate OCAP (Ownership, Control, Access, and Possession) principles as described in TCPS~~ [~~Article 9.8~~](https://ethics.gc.ca/eng/tcps2-eptc2_2018_chapter9-chapitre9.html#8)~~?~~  ~~[ ] Yes. Explain how.~~  ~~[ ] No. Explain why not.~~ |

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| **2.12** **Clinical trials**  [ X ] Not applicable – go to 2.13 |
| ~~2.12.1 Will the proposed clinical trial be registered?~~  ~~[ ] No. Explain why not.~~  ~~[ ] Yes. Indicate where it was/will be registered and provide the registration number.~~ |
| ~~2.12.2 If a novel intervention or treatment is being examined, describe standard treatment or intervention, to indicate a situation of clinical equipoise exists (TCPS~~ [~~Chapter 11~~](http://www.pre.ethics.gc.ca/eng/tcps2-eptc2_2018_chapter11-chapitre11.html)~~). If placebo is used with a control group rather than standard treatment, please justify.~~ |
| ~~2.12.3 Clearly identify the known effects of any product or device under investigation, approved uses, safety information and possible contraindications. Indicate how the proposed study use differs from approved uses.~~  ~~[ ] Not applicable~~ |
| ~~2.12.4 Discuss any plans for blinding/randomization.~~ |
| ~~2.12.5 What plans are in place for safety monitoring and reporting of new information to participants, the REB, other team members, sponsors, and the clinical trial registry (refer to TCPS~~ [~~Articles 11.6, 11.7, 11.8~~](http://www.pre.ethics.gc.ca/eng/tcps2-eptc2_2018_chapter11-chapitre11.html)~~)? These should address plans for removing participants for safety reasons, and early stopping/unblinding/amendment of the trial. What risks may arise for participants through early trial closure, and how will these be addressed? Are there any options for continued access to interventions shown to be beneficial?~~ |

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| **2.13** **Use of personal health information**  [ X ] Not applicable |
| ~~2.13.1 Research using health information may be subject to Nova Scotia’s~~ [*~~Personal Health Information Act~~*](http://novascotia.ca/dhw/phia/)~~. Describe the personal health information (~~[~~definition explained in the guidance document~~](https://cdn.dal.ca/content/dam/dalhousie/pdf/research-services/REB/Dal%20REB%20Application%20Instructions%20-%20Prospective%20Research%20%20v2021-02.pdf)~~) required and the information sources, and explain why the research cannot reasonably be accomplished without the use of that information. Describe how the personal health information will be used, and in the most de-identified form possible.~~ |
| ~~2.13.2 Will there be any linking of separate health data sets as part of this research?~~  ~~[ ] No~~  ~~[ ] Yes~~  ~~If yes:~~  ~~A) Why is the linkage necessary?~~  ~~B) Describe how the linkage will be conducted (it is helpful to append a flow diagram)~~  ~~C) Does that linkage increase the identifiability of the participants?~~ |
| ~~2.13.3 Describe reasonably foreseeable risks to privacy due to the use of personal health information and how these will be mitigated.~~ |

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| **2.14** **Data Repositories**  [ X ] Not applicable |
| ~~2.14.1 Identify and describe the data repository in which the research data will be deposited. What is its focus, who are its target users, who can access deposited data and under what circumstances? For how long will the data be kept in the repository?~~ |
| ~~2.14.2 Describe the data set to be released to the repository. If there is personal and/or sensitive information in the data, describe how you will prepare the data for submission to the repository and mitigate risks to privacy. Identify all fields that will be included in the final data set (include as an appendix).~~ |
| ~~2.14.3 Is agreeing to have one’s data deposited a requirement for participation in the study? If yes, provide a justification. If no, indicate how participants can opt in or out.~~ |

## SECTION 3. APPENDICES

**Appendices Checklist.** Append all relevant material to this application in the order they will be used. This may include:

[ X ] Reference list

[ n/a ] Permission or support/cooperation letters (e.g. Indigenous Band Council, School Board, Director of a long-term care facility, anyone whose permission you need to conduct recruit participants or conduct research)

[ n/a ] Research agreements (required for research involving Indigenous communities)

[ X ] Recruitment documents (posters, oral scripts, online postings, invitations to participate, etc.)

[ n/a ] Screening documents

[ X ] Consent/assent documents or scripts

[ X ] Research instruments (questionnaires, interview or focus group questions, etc.)

[ n/a ] Debriefing and/or study results templates

[ n/a ] List of data fields included in data repository

[ n/a] Confidentiality agreements

**Consent Form Templates**

Sample consent forms are provided on the [Research Ethics website](https://www.dal.ca/dept/research-services/responsible-conduct-/research-ethics-/resources-.html) and may be used in conjunction with the information in the [*Guidance*](https://cdn.dal.ca/content/dam/dalhousie/pdf/research-services/REB/Dal%20REB%20Application%20Instructions%20-%20Prospective%20Research%20%20v2021-02.pdf) document to help you develop your consent form.

# APPENDIX A – Reference List

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# APPENDIX B – RECRUITMENT DOCUMENTS

**TABLE TENNIS (PING PONG) SKILLS TRAINING AND TRANSFER BETWEEN VIRTUAL AND REAL ENVIRONMENT**

The Human Computer Interaction group at Dalhousie University is currently recruiting individuals with no prior experience or individuals who have played table tennis no more than once a month in the past five years and have not had any formal training as a novice to participate in a research study focused on table tennis skill training and transfer between virtual reality (VR) and real-life settings. We will begin with the first phase of the study (VR training) and we will assess your initial table tennis skills in a real-life session. Following that, a qualified coach will provide table tennis training using virtual reality technology for a series of five sessions. At the end of the training, we will evaluate your skills once again in a real-life table tennis session.

For the second phase of the study, we will require a separate group of participants. Similarly, we will assess your baseline table tennis skills in a virtual reality session, followed by a five-session training program conducted by a coach in real-life table tennis. Finally, we will assess your skills once more in a virtual reality setting.

Aside from obtaining your verbal/written information about your experience, we will conduct additional assessments during the first session. We want only novice players who have no prior experience or who have played table tennis no more than once a month in the past five years and have not had any formal training to participate in the study. We will have you self-report your playing time and experience, including professional training. Moreover, in the first session, we will evaluate your skill level to ensure that we do not recruit individuals who are already highly proficient in table tennis. To achieve this goal and to ensure the efficient use of your time, the coach will conduct a quantitative assessment of your skill during the pre-test, evaluating your performance in serving and returning a ball. If you score above 60% on both serving and returning a ball, you will be excluded from the study, as you will be considered to have significant experience in the sport. We will use the same evaluation schemes for virtual reality and real-life studies. If you are screened out due to table tennis experience, you will be informed that you cannot do the user study. However, you will still be offered the opportunity to play table tennis without recording your data. You will also be paid for participating in this first session.

Data collected in this study will be stored for a limited time duration in a private SharePoint list, the Dalhousie university institutional cloud storage platform.

If you choose to participate, you will contribute valuable insights to our understanding of the transfer of table tennis skills between virtual and real-life environments. Your involvement will require attending the assessment and training sessions as scheduled, and your confidentiality and privacy will be strictly maintained throughout the study.

In order to participate in this user study, it is required that you are able to attend the study sessions in person at the Paramount Building located at Dalhousie Sexton Campus and Halifax Campus.

Participation in this study is entirely voluntary, and we greatly appreciate your willingness to take part. Participants will receive 9 CAD after each experiment before leaving the lab. At the end of the 7 sessions, participants will receive a total of 9 CAD per day \* 7 days = 63 CAD as compensation for their participation.

If you are interested in participating, please contact Kissinger Sunday, the student running the user study by writing an email to [Kissinger.Sunday@dal.ca](mailto:Kissinger.Sunday@dal.ca), and you will receive further information on how to proceed with your participation.

The supervisor running this study is Dr. Mayra Barrera. If you have questions, you are encouraged to contact her at [mbarrera@dal.ca](mailto:mbarrera@dal.ca).

This research has been reviewed and approved by a Research Ethics Board (IRB) at Dalhousie University. The approval number is XXXX-XXXX-XXX.



Image taken from: <https://www.theindianwire.com/wp-content/uploads/2018/08/table-tennis.jpeg>

1. APPENDIX C – CONSENT FORM

## C.1. STUDY INFORMATION PRESENTED PRIOR TO CONSENT FORM

**Project title:** Skills Training and Transfer between Virtual Reality and Real Life.

**Lead researcher:** Kissinger Sunday, PhD Student, Kissinger.Sunday@dal.ca, Faculty of Computer Science, Dalhousie University.

**Other researchers**

Mayra Donaji Barrera Machuca, mbarrera@dal.ca

Anil Ufuk Batmaz, Concordia University, [ufuk.batmaz@concordia.ca](mailto:ufuk.batmaz@concordia.ca)

Junwei Sun, Simon Fraser University, [junwei.s@yahoo.com](mailto:junwei.s@yahoo.com)

Yiwei Li, University of Western Ontario, [yli922@uwo.ca](mailto:yli922@uwo.ca)

Heather Neyedli, Dalhousie University, [hneyedli@dal.ca](mailto:hneyedli@dal.ca)

Rina Wehbe, Dalhousie University, rina.wehbe@dal.ca

**Funding provided by:** This project is funded by Dalhousie Belong Fellowship (No. R35819).

**Introduction**

We invite you to participate in a research study conducted by Kissinger Sunday, a PhD student at the Faculty of Computer Science, Dalhousie University. Your decision to take part in this research is entirely voluntary. The information provided below outlines the details of the study, including your involvement, potential benefits, risks, inconveniences, and any discomfort you may experience. If you have any inquiries or concerns, please feel free to discuss them with Kissinger Sunday. You are encouraged to ask as many questions as you need to make an informed decision. If you have any questions later on, please contact him at [Kissinger.Sunday@dal.ca](mailto:Kissinger.Sunday@dal.ca).

**Purpose and Outline of the Research Study**

The primary objective of this study is to enhance our understanding of skill transfer between virtual reality (VR) and real-life (RL) environments in the context of table tennis. We aim to investigate the extent to which skills acquired in training can be effectively transferred among individuals who engage in Eleven Table Tennis (ETT), real-life table tennis, or both.

Additionally, we intend to measure the physical activity levels of VR players and identify the specific muscles that are engaged and trained during the training process. This will provide insights into the physical demands and benefits of VR table tennis compared to traditional RL play.

The study consists of two user studies. The first study focuses on training participants in specific skills within the VR environment, including ball serve, backhand and forehand spin, consistency, footwork, speed, and overall performance. The second study, on the other hand, concentrates on training participants in the same set of skills in the RL setting.

Following the training sessions, we will conduct a post-test session to evaluate the transfer of these skills between the VR and RL environments. Participants will also be given the opportunity to share their experiences and provide feedback on their overall study participation.

By conducting these user studies, we aim to contribute valuable insights into the transferability of table tennis skills between VR and RL, as well as the potential physical benefits associated with VR training.

Top of Form

The entire user study will require participants to attend five one-hour training sessions, including two hours and forty minutes for pre- and post-evaluations, resulting in a total time frame of approximately 7.5 hours. This duration includes the study time, breaks, survey completion, and reading the consent form. Participants will receive 9 CAD after each experiment before leaving the lab. This incentive aims to ensure that participants remain engaged throughout the study and maintain contact with the research team. At the end of the 7 sessions, participants will receive a total of 9 CAD per day \* 7 days = 63 CAD as compensation for their participation

**About Eleven Table Tennis (ETT)**

Eleven Table Tennis (ETT) is a virtual reality (VR) game available on Oculus and Steam platforms. Developed by Fun Labs, ETT was first released in 2016. To obtain more information about ETT, please visit their official website at <https://elevenvr.com/>.

**Who Can Take Part in the Research Study**

You are eligible to participate in this study if you have no prior experience or you have played table tennis no more than once a month in the past five years and have not had any formal training as a novice.

**What You Will Be Asked to Do**

If you choose to participate in this research, you will be required to visit the lab on a specific date and time to take part in the user study. The study will consist of approximately 60 minutes of training and 80 minutes of pre- and post-evaluations. Prior to the study, you will be asked to complete a screening questionnaire to assess your level of experience in table tennis. Based on your responses, it will be determined whether you can proceed with the experiment or not.

If all the available spots in a particular group are already filled, you will not be able to participate in the experiment. In such cases, the questionnaire you completed will be securely destroyed. However, it's important to note that you will still have the opportunity to play table tennis either in virtual reality (VR) or in real life (RL), depending on your preference.

If you are able to continue with the experiment, you will be provided with a consent form to read and sign. Additionally, you will be asked to complete a survey that gathers demographic information. Subsequently, you will be assigned to either the VR group or the RL group for the pretest study. If you are initially assigned to the VR group, you will undergo a pretest in the VR environment before proceeding to the RL training. On the other hand, if you are initially assigned to the RL group, you will undergo a pretest in the RL setting before moving on to the VR training. Following the training, a post-test will be conducted in the corresponding environment (VR or RL).

In both studies, your level of physical activity will be measured using a heart rate monitor called E4 Empatica. Additionally, muscle activity will be measured using an EMG device called Mobi6. These devices will help us assess your physical exertion and muscle activation during the study.

After completing the experiment, you will be invited to share your feedback regarding your overall experience. Your input and insights are valuable in helping us understand the study's effectiveness and any areas for improvement.

**Possible Benefits, Risks and Discomforts**

Your participation in this study will also help us advance research in Human Computer Interaction and contribute to developing a new table tennis application to train players. The findings obtained from this research will also advance our understanding of physical fitness between VR and RL.

The risks associated with this study are minimal; there are no known physical or psychological risks for participating in this research. However, participants may experience feelings of boredom, exertion, frustration, anxiety, or fatigue during the study, which are common in physical activities and skill training tasks. Additionally, participants may feel less confident due to perceived performance. To mitigate these risks, participants are encouraged to take breaks and complete the study at their own pace.

**Compensation / Reimbursement**

You will receive a compensation of 63 CAD for participating in the entire study, which consists of 7 sessions. In the event that you are screened out and unable to continue, you will receive a token gift for attending the lab. As payment will be provided after each lab activity, you are free to discontinue your involvement at any time by informing the lead researcher conducting the study.

**How your information will be protected:**

During the pre-post experiment, your activities will be recorded on video to analyze the specific skills successfully transferred to the other environment (VR or RL). All recordings will be de-identified to ensure your anonymity. We will maintain strict confidentiality and security of the data, including the information you provide. Only the research team will have access to the identifying information, and any data that may reveal your identity will be removed before sharing it with individuals outside the team. All team members are obligated to maintain confidentiality.

Your identifying information, collected through the demographic survey (such as gender, age, experience, etc.), will be securely stored separately from the research data. Throughout the study, electronic records will be password-protected and stored securely on an encrypted external hard drive. The hard drive will be kept in a locked filing cabinet within the researcher's office.

The findings of the study will be described and shared in theses/dissertations, conference presentations, and journal articles. However, individual results will not be reported, and your identity will remain confidential in all reports.

Upon completion of the study, your identifying information will be deleted within two years of the research project's completion.

The anonymous data collected in this study will be initially stored using Microsoft OneDrive and stored for a limited duration in a private SharePoint list, which is the institutional cloud storage platform of Dalhousie University.

Top of Form

**If You Decide to Stop Participating**

You have the freedom to withdraw from the study at any point by informing the researcher conducting the user study. If you choose not to submit the survey after completing it, your answers will not be stored. Once the survey is submitted, we cannot remove your data as we do not retain any information that can be linked back to your responses.

**How to Obtain Results**

We will share a brief summary of the study's group results once it is completed. However, individual results will not be provided. Approximately 12 months from now, you can access these results by visiting <http://mayradonaji.com/>.

**Questions**

We are available to address any questions or concerns you may have regarding your participation in this research study. Please feel free to reach out to Kissinger Sunday ([Kissinger.Sunday@dal.ca](mailto:Kissinger.Sunday@dal.ca)) at any time if you have any inquiries, comments, or concerns about the study.

If you have any ethical concerns regarding your participation in this research, you may also contact the Research Ethics Office at Dalhousie University. They can be reached at (902) 494-3423 or via email at [ethics@dal.ca](mailto:ethics@dal.ca) (please reference REB file # 20XX-XXXX).

# APPENDIX D – SURVEY

**Pre-Study Questionnaire**

Date:

Participant Number:

Experiment Name: Skills Training and Transfer between Virtual Reality and Real Life.

**Age**:

1. 18-24 years old
2. 25-34 years old
3. 35-44 years old
4. 45 years old and above

**Gender**:

1. Male
2. Female
3. Non-binary
4. Transgender
5. Genderqueer
6. Genderfluid
7. Agender
8. Two-Spirit
9. Other

**Dominant Hand:**

1. Right-handed
2. Left-handed
3. Ambidextrous (equally skilled with both hands)
4. Prefer not to say

**VR Table tennis (ETT or similar game)**

1. Have you ever played table tennis (or ping pong) in VR?
   1. Yes
   2. No

If yes, the following question will show:

How frequently do you play?

1. Once a month
2. More than once a month

**Real Life Table tennis (RL)**

1. Have you ever played table tennis (or ping pong) in RL?
   1. Yes
   2. No

If yes, the following question will show:

How frequently do you play?

1. Once a month
2. More than once a month

**VR experience**

1. Do you have VR experience?
   1. Yes
   2. No

If yes, the following question will show:

1. What did you do in VR?

**Physical Fitness**

7. How physically fit are you? Choose on a scale of 1-10 with 1 being “very, very unfit” and 10 being “very, very fit

|  |  |
| --- | --- |
| **1-10** | |
| 1 |  |
| 2 |  |
| 3 |  |
| 4 |  |
| 5 |  |
| 6 |  |
| 7 |  |
| 8 |  |
| 9 |  |
| 10 |  |

6. Do you engage in any form of physical activity such as sports?

a. Yes

b. No

If yes, these questions will show:

7. What kind of sport?

8. How many times a week do you engage in sport?

**Workload Assessment Questionnaire (NASA TLX)**

Date:

Participant No:

Experiment Name: Evaluating 3D Sketching Interactions with Eye Tracking System

**Mental Demand**

How much mental demand did this task require on you?

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Extremely  Low |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Extremely  High |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

**Physical Demand**

How much physical demand did this task require on you?

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Extremely  Low |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Extremely  High |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

**Temporal Demand**

How fast was the speed required to complete this task?

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Extremely  Low |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Extremely  High |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

**Performance**

How successful were you in fulfilling the task that was asked of you?

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Excellent |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Unsuccessful |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

**Effort**

How difficult was it to complete this task relative to your performance liking?

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Extremely  Low |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Extremely  High |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

**Frustration\ Failure**

How angry were you, stressed, angry, discouraged?

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Extremely  Low |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Extremely  High |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

**Simulator Sickness Questionnaire (SSQ)**

Date:

Participant Number:

Experiment Name: Skills Training and Transfer between Virtual Reality and Real Life.

Please tick the boxes in the table below to express your current situation:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Symptom | Not at All | A little bit | Quite a bit | Very much |
| Discomfort |  |  |  |  |
| Tiredness |  |  |  |  |
| Headache |  |  |  |  |
| Eye strain |  |  |  |  |
| Difficulty focusing |  |  |  |  |
| Increase in saliva |  |  |  |  |
| Sweating |  |  |  |  |
| Nausea |  |  |  |  |
| Difficulty concentrating |  |  |  |  |
| A feeling of being full in mind |  |  |  |  |
| Blurred vision |  |  |  |  |
| Difficulty balancing with eyes open |  |  |  |  |
| Difficulty balancing with eyes closed |  |  |  |  |
| Dizziness |  |  |  |  |
| Stomach awareness |  |  |  |  |
| Burping |  |  |  |  |
| Total |  |  |  |  |

**Post-Study Questionnaire**

Experiment Name: Skills Training and Transfer between Virtual Reality and Real Life.

**Participant No: Date:**

* 1. What limitations do you think there are in virtual reality (eleven table tennis) compared to real-life?

|  |
| --- |
|  |

* 1. How does playing table tennis in virtual reality affect your performance in real-life?

|  |
| --- |
|  |

* 1. How does playing table tennis in real-life affect your performance in virtual reality.

|  |
| --- |
|  |

* 1. What skill(s) did you transfer from virtual reality to real-life?

|  |
| --- |
|  |

* 1. What skill (s) did you transfer from real-life to virtual reality?

|  |
| --- |
|  |

* 1. Circle the top three areas of your muscle you think you trained in virtual reality.

A picture containing joint, muscle, stomach, chest

Description automatically generated

Image taken from: https://www.registerednursern.com/muscle-anatomy-quiz/

* 1. Circle the top three areas of your muscle you think you trained in real-life?

A picture containing joint, muscle, stomach, chest

Description automatically generated

Image taken from: https://www.registerednursern.com/muscle-anatomy-quiz/

Any other comments?

**BORG RATING OF PHYSICAL EXERTION**

**Experiment Name:** Skills training and transfer between VR and RL

|  |  |
| --- | --- |
| **0-10 Borg Rating of Perceived Exertion Scale** | |
| 0 | Rest |
| 1 | Really Easy |
| 2 | Easy |
| 3 | Moderate |
| 4 | Sort of Hard |
| 5 | Hard |
| 6 |  |
| 7 | Really Hard |
| 8 |  |
| 9 | Really, Really Hard |
| 10 | Maximal; just like my hardest race |

# Immersion questionnaire

**Experiment Name:** Skills training and transfer between VR and RL

**Instructions:** To what degree do the following statements correspond to your feelings and experiences during training in VR? Please indicate with a cross on the scale. The number represents how well the statement describes your experience, with 1 being "strongly disagree" and 7 being "strongly agree".

Strongly Strongly

Disagree Agree

1 2 3 4 5 6 7

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | While training, I lost track of time |  |  |  |  |  |  |  |
| 2 | I found it difficult to stay focused |  |  |  |  |  |  |  |
| 3 | My attention was so focused on the activity that I forgot about the surroundings |  |  |  |  |  |  |  |
| 4 | At times, I completely forgot that I was in the middle of an experiment |  |  |  |  |  |  |  |
| 5 | I was so concentrated on the activity that I forgot the world around me |  |  |  |  |  |  |  |
| 6 | I was immersed in the activity during training |  |  |  |  |  |  |  |
| 7 | I was confused or disoriented at the beginning of breaks or at the end of the experimental session |  |  |  |  |  |  |  |
| 8 | My experiences in the virtual environment seem consistent with my real-world experiences. |  |  |  |  |  |  |  |
| 9 | I could easily move or manipulate objects in the virtual environment |  |  |  |  |  |  |  |
| 10 | My sense of moving around the virtual environment was compelling |  |  |  |  |  |  |  |
| 11 | I could easily examine objects from multiple viewpoints. |  |  |  |  |  |  |  |
| 12 | I was aware of my display and control devices |  |  |  |  |  |  |  |

# **Physical Activity Enjoyment Scale (PACES-8)**

**Experiment Name:** Skills training and transfer between VR and RL

**Instructions:** To what degree do the following statements correspond to your feelings and experiences of enjoyment during training in VR/RL? Please indicate with a cross on the scale. The number represents how well the statement describes your experience, with 1 being "strongly disagree" and 7 being "strongly agree".

Strongly Strongly

Disagree Agree

1 2 3 4 5 6 7

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | I find it pleasurable |  |  |  |  |  |  |  |
| 2 | It's a lot of fun |  |  |  |  |  |  |  |
| 3 | It’s very pleasant |  |  |  |  |  |  |  |
| 4 | It’s very invigorating |  |  |  |  |  |  |  |
| 5 | It’s very gratifying |  |  |  |  |  |  |  |
| 6 | It’s very exhilarating |  |  |  |  |  |  |  |
| 7 | It’s very stimulating |  |  |  |  |  |  |  |
| 8 | It’s very refreshing |  |  |  |  |  |  |  |

**International Physical Activity Questionnaire**

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you did during the period of experiment.

* 1. During the **last 7 days**, on how many days did you do **vigorous** physical activities?

## days per week

No vigorous physical activities ***Skip to question 3***

* 1. How much time did you usually spend doing **vigorous** physical activities on one of those days?

## hours per day

**minutes per day**

Don’t know/Not sure

Think about all the **moderate** activities that you did in the **last 7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

* 1. During the **last 7 days**, on how many days did you do **moderate** physical activities?

## days per week

No moderate physical activities ***Skip to question 5***

* 1. How much time did you usually spend doing **moderate** physical activities on one of those days?

## hours per day

**minutes per day**

Don’t know/Not sure

Think about the time you spent **walking (movement)** in the **last 7 days during the experiment**.

* 1. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?

## days per week

No walking ***Skip to question 7***

* 1. How much time did you usually spend **walking** on one of those days?

## hours per day

**minutes per day**

Don’t know/Not sure

The last question is about the time you spent **sitting during the experiment.**

* 1. During the **last 7 days**, how much time did you spend **sitting** on a **week day**?

## hours per day

**minutes per day**

Don’t know/Not sure

**This is the end of the questionnaire, thank you for participating.**

**Table Tennis Training Protocol for 5 Sessions**

The following protocol will be implemented to train participants in table tennis skills over the course of five one-hour sessions, following the guidelines outlined by McAfee [12].

Day 1:

* Warm-up exercises and stretching for 10 minutes.
* Serving (short/long): Focus on serving and returning the ball
* Forehand attack: Focus on teaching the fundamental table tennis strokes, such as forehand.
* Footwork Drills: Practice basic footwork movements, such as side shuffles and forward-backward steps, to improve agility and positioning.
* Basic top spin serve: Introduction to basic top spin serve and allow participants to practice serving techniques
* Game-based Drills. Engage participants in simple game-based drills to apply the learned techniques and footwork in a simulated match-like setting.

Day 2:

* Warm-up exercises and stretching for 10 minutes
* Review forehand attack and top spin serve.
* Backhand attack: Introduction to backhand attack fundamentals.
* Game-based Drills: Continue with game-based drills that focus on specific aspects of the game, such as backhand attack.

Day 3:

* Warm-up: Repeat the warm-up routine from previous days for 10 minutes.
* Forehand loop: Introduction to looping using forehand.
* Basics of backspin serves.
* Match Play: Allow participants to engage in practice matches to apply the learned skills and tactics in a competitive setting.

Day 4:

* Warm-up: Repeat the warm-up routine from previous days for 10 minutes.
* Backspin serves. Continue with backspin serve and introduce push backspin and forehand loop.
* Match Play: Allocate dedicated time for participants to engage in match play with a focus on implementing learned strategies and skills.

Day 5:

* Warm-up: Repeat the warm-up routine from previous days (10 minutes).
* Forehand attack and backhand attack: Review and reinforce forehand attack and backhand attack.
* Scenario-based Training: Create specific game scenarios and challenges for participants to apply their skills and decision-making abilities.
* Match Play and Evaluation: Conclude the training program with match play sessions, followed by a brief evaluation of individual progress, strengths, and areas for further improvement.

Scoring criteria to various table tennis skills

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **SN** | **Skill** | **Protocol** | **Scoring criteria** | **Cap Streak** | **Score** |
| 1 | Forehand | Hitting the ball using the forehand | Count the number of successful hits in a row in a game | If a player achieves 10 or more successful hits in a row, the scoring process stops counting additional points beyond the 10th hit. | \_\_\_\_/100 |
| 2 | Backhand counter hit | Hitting the ball using the backhand | Count the number of successful hits in a row in a game | If a player achieves 10 or more successful hits in a row, the scoring process stops counting additional points beyond the 10th hit. | \_\_\_\_/100 |
| 3 | Consistency and Accuracy | Continuously hitting a target on the table | Count the number of successful hits on the target | If a player achieves 10 or more successful hits on the target, the scoring process stops counting additional points beyond the 10th hit. | \_\_\_\_/100 |
| 4 | Serve (short serve) | Place smaller targets near the middle of the table and try to hit the targets. | Count the number of targets you can hit in a game | If a player achieves 10 or more successful hits on the target, the scoring process stops counting additional points beyond the 10th hit. | \_\_\_\_/100 |
| 5 | Serve (Long serve) | Place large target near the end of the table and try to hit the targets. | Count the number of targets you can hit in a game | If a player achieves 10 or more successful hits on the target, the scoring process stops counting additional points beyond the 10th hit. | \_\_\_\_/100 |
| 6 | Returning serves | Put a target on the table and try to get the ball to hit the target with your return. | Count the number of targets you can hit in a game | If a player achieves 10 or more successful hits on the target, the scoring process stops counting additional points beyond the 10th hit. | \_\_\_\_/100 |
| 7 | Footwork | Play a game where you are not allowed to smash the ball. Try to win the point by out positioning your opponent. | Count the shuffle step to see if it covers the table when the opponent is placing the ball all around the table | If a player achieves 10 or more successful steps when the opponent places the ball, the scoring process stops counting additional points beyond the 10th hit. | \_\_\_\_/100 |
| 8 | Forehand topspin | Start by doing some forehand pushes to each other to make sure you are getting the correct feeding ball for the topspin. | Count the number of topspins made during the game. Each time the player successfully imparts topspin on the ball, it counts as one topspin. | If a player achieves 10 or more successful topspins during the game, the scoring process stops counting additional points beyond the 10th hit. | \_\_\_\_/100 |
| 9 | Backhand topspin | Start by doing some backhand pushes to each other to make sure you are getting the correct feeding ball for the topspin. | Count the number of topspins made during the game. Each time the player successfully imparts topspin on the ball, it counts as one topspin. | If a player achieves 10 or more successful topspins during the game, the scoring process stops counting additional points beyond the 10th hit. | \_\_\_\_/100 |