# Learning choreography through visual perspective-taking

Georgios Lampropoulos
Leiden University
Media Technology
g.lampropoulos1987@gmail.com
August 2015
Edwin van der Heide || Peter van der Putten

## ABSTRACT

The current paper introduces the research conducted on the effect of visual perspective-taking in the task of learning a choreography. The research was based on the assumption that perspective-taking has positive effects on human cognition. It has been proven useful for passing knowledge from an expert and can be applied visually, in a virtual environment. This research intends to determine perspective-taking' s effect in the area of dance. It focuses on the task of learning a choreography and how this could be assimilated in a virtual dance environment. For this reason, an experiment was designed to test the participants' capacity to learn a choreography from two different perspectives(allocentric and egocentric). We investigated the user performance and experience regarding the aforementioned perspectives, including measurements such as time, user confidence and spatial awareness. The research concluded that there was no significant difference in terms of learning time between the two different perspectives. In the case of user experience, the allocentric approach felt more natural and people were more aware of the movement.

## Keywords

perspective-taking, frame of reference, dance, choreography, first person view, virtual reality

## 1. INTRODUCTION

The past few years, affordable rugged high-quality head-mounted cameras have developed a new trend in sport videos. Amateurs and professionals record themselves from a first person point of view, providing immersive videos to their audience. This new perspective, apart from a whole new approach in sport video making, it could provide a new method of learning, in sport or other physical activities.

Changing a person's perspective on a topic or experience can impact his learning ability. It changes his approach to understanding a topic. We can distinguish between cognitive perspective-taking and visual perspective-taking. In the former case, people cognitively put themselves in another' s position, thus simulating his point of view on a concept. In the latter, people change their point of view and visualize another' s point of view. In that instance we determine two different perspectives, allocentric and egocentric. From an allocentric perspective someone observes things from a different point of view than of the person' s of interest. Whereas from an egocentric perspective, one observes things as the person of interest does.

In past studies, research participants were asked to cognitively simulate the perspective of an expert. The participants demonstrated increased learning and performance[1, 16, 17]. Another study suggests that there may be benefits for virtual perspective-taking, that are akin to the positive effects of cognitive perspective-taking, found in studies of more traditional perspective-taking intervention[8]. Moreover, in a study researching the effects of perspectives on group performance in collaborative navigation, results favor an egocentric approach perspective display[20].

In activities like dance, observational learning constitutes the major mode of movement learning[6]. The teacher shows the moves to the class participants and they are required to copy them while the lesson/choreography progresses. This way the dancers learn from an allocentric, with respect to their teacher, perspective.

Based on these observations, we hypothesize that a change of perspective can have beneficial results in the course of learning an activity, particularly in the course of learning a choreography. To prove this hypothesis, we investigate a perspective-taking approach in a dance class environment and explore whether an egocentric approach would improve the ability of students in adapting to a new choreography. Specifically, this study examines whether taking an egocentric perspective is more efficient in learning a choreography than a traditional exocentric, third person view, perspective. We also concentrate on other aspects of this process that relate with the participants and their personal experience.

In the following sections, we will go through the scientific background supporting our research(section 2). The main idea and content of our research will be introduced(section 3) and the experimental process will be explained(section 4). Finally, the results will be presented(subsection 4.5), followed by a discussion regarding the research before we reach the conclusion of our work(section 6).

## 2. BACKGROUND

At this point, our attention will focus on the scientific background of our subject. The main elements of the research and the related work will be introduced.

### 2.1 Perspective-taking

Perspective-taking is the process by which an individual views a situation from a different point of view, the point of view of another person[5]. It can occur either cognitively, by mentally simulating the point of view of someone else' s cognitive state, or visually in a way that someone sees what someone else does.

In terms of visual perspective-taking, we can distinguish between egocentric and allocentric perspectives. In an egocentric perspective, objects are represented or described with respect to one's own body, or differently stated, a frame of reference[14, 19] originated from one's own body. In an allocentric perspective, objects are represented or described with respect to each other or to a frame of reference outside one's body. In other words, we have a specific frame of reference. This frame of reference originates, per se, from the point of view of another human. When one adopts an allocentric perspective, he observes things from a point of view outside this frame of reference. The center of attention is not centered to him but to a point/frame other(allo) than him. Everything is described with respect to this frame of reference, e.g a box is situated 30 degrees on the left of the person of interest(frame of reference). On the other hand, when someone adopts an egocentric perspective, he, as an observer, identifies himself with the frame of reference outside his body. That way, the origin of the frame of reference becomes the origin of his own point of view and he describes everything with respect to himself(ego), thus transposing oneself to the center of the attention(e.g a box is situated 30 degrees on my right).

The point of view can affect the level of embodiment or disembodiment that someone feels. The mind is locked in a body that, at any time, occupies a specific place and faces a specific direction. These undeniable facts form part of the basis for embodied cognition[18]. By "changing" body we can alter our embodied cognition and receive information important to our intentions and indistinguishable from the other point of view. This task can be challenging and confusing since the user should change the mental representation of his world, depending on the current frame of reference.

Changing one' s perspective leads to a new mental representation of his environment. Different information come into his focus, contributing to a different and potentially better understanding of a certain situation or experience.

In tasks that involve knowledge passing from an expert this approach can lead to better and faster absorption of knowledge. Experts see their domain of expertise completely differently than non experts. Their experience and knowledge have led them to develop more reliable judgment of the situation and ability to focus on important elements. By focusing someone' s attention on what experts consider important, users can take advantage of it.

Such prospects can be realized through a virtual reality environment. In this environment, it is feasible to offer to the users different visual perspectives and also guide them through an expert' s perspective.

## 2.2 Dance

Dance is the art form that makes use of human movement created and expressed for aesthetic purpose. Music usually accompanies dance giving tempo and intensity. It often tells a story coated with the corresponding mime, costumes and scenery. In order for these elements to come into place, many different techniques and materials can be used to realize a dance performance. New media and technologies have conduced to the development of this art form, by offering new grounds of experimentation and opportunities to dancers and choreographers [9]. Thus promoting a wide field of research.

Dance research can vary from theoretical to more practical matters. From history of dance or the design of choreography, to the use of sensors or other technological advancements in a performance or dance education.

Dance can be decomposed in many different elements. A dance performance mainly consists of the choreography, that is the sequence of movements designed. The design of the choreography includes space and inter-person relationships. Music gives the rhythm. To perform a choreography, dancers not only have to follow the correct movement sequence, but to incorporate skills, sensibility and pace to communicate several feelings and messages to the audience. This requires many hours of practice and planning to create an aesthetically pleasant result.

Namely, dancers and choreographers need to work together in order to improve the final result. Dancers require to memorize a choreography, prepare it and rehearse it, so that they acquire a certain level of performance and expression. The level of experience and knowledge each dancer possesses, play an important role in this whole process.

To obtain a certain level of experience and knowledge, dancers pass through years of training. Throughout these years they manage to learn and perform different choreographies that help them evolve. In a traditional dance class environment, students/dancers are shown a choreography and they follow the steps. Through repetition of this process they manage to learn the choreography and in the course of time perfect their movements.

In this research we will try to investigate whether a change in the traditional way someone learns a choreography can benefit his ability to learn it faster.

## 2.3 Related Work

At this point, we will, therefore, concentrate our attention to studies that have already been carried out and relate to the purpose of this research. Moreover, we will develop the reasoning this study was based on and acquired form.

Basic aspect of this research is the perspective-taking. Several studies have been published, in the past, concerning perspective taking and its influence on human cognition. The following studies drew our attention, into further examining this interesting aspect.

In the study published by R.S. Siegler[16], children were presented conservation problems. In particular, children were shown two rows of buttons. Each time they would conduct the experiment these rows of buttons were modified by the experimenter. The experimenter changed the length of the rows by either adding/taking away buttons or by spatially displacing the buttons. Then the children were asked to indicate which, if either, row had a greater number of buttons. The children were assigned to three groups: no feedback, feedback plus explain own reasoning, feedback plus explain experimenter's reasoning. In the latter groups, children were provided feedback concerning their answer and asked to explain themselves or the experimenter's reasoning. Children that were asked to explain the experimenter's reasoning, thus adopting/taking the experimenter's perspective provided correct answers more often than children in the other two groups.

Traxler et al[17], studied the effect of perspective-taking in written communication. It was based on the assumption that, writers who performed an activity that provided them with their readers ' perspective would improve their texts when they revised them. For this reason they designed the following experiment. In the context of the experiment, a group of the participants, the writers, should describe several geometric figures. In the first part of the experiment, the writers described a set of geometrical figures and the second group of participants, the readers, tried to match the descriptions with the corresponding figures. On the second part of the experiment, the writers were parted in two groups. The members of the first group(selection group) undertook a selection process. They read descriptions of geometric figures that were written in the first part of the experiment and matched them with figures. This way, they changed their perspective into the reader's perspective. The second group was given a set of questions and 40 figures in set of fours. They were asked to compare the figures contained in each set and rank them, according to the questions. Both groups, were finally asked to revise the descriptions they made during the first part of the experiment. The same reading procedure was followed and the results proved that people who had been exposed to the same procedure as the readers did, thus taking the reader's perspective, improved their written communication towards the readers.

A significant characteristic of perspective-taking, that can extend the research related to it, to different areas, like Virtual Reality, is the fact that it can occur visually. As it was mentioned before, instead of just cognitively simulating the change of perspective, people can experience it through their visual system.

This approach was investigated in the studies from Yang et al[20] and R. Lindgren [8].

In the first study, "the effect of the dimension of egocentric-exocentric perspectives on collaborative navigation performance" is investigated. A collaborative navigation task was described in a CVE(Collaborative Virtual Environment). The participants were asked to complete this task using different perspectives. Several performance indicators were measured leading to the conclusion that an egocentric perspective display is favorable.

In their research, Yang et al implemented a a task in a three dimensional collaborative environment. They created a virtual water tank. The participants had to collaborate and drive a virtual submarine to find some targets. One participant had the role of the driver and second participant was the guider. The guider was the only one who could see the target. They tested different visual perspectives for the guider. He could see exactly what the driver saw(egocentric perspective) or have a more allocentric perspective, Figure 1. To test their setup, they measured the time required the users to find a target, namely the target enters the field of view of the guider. They also measured the time it took them to hit the target after they had spotted it.

In the second study, the effects of perspective-taking in generating a learning stance were examined. Two different videos, displaying a set of simulation events, executed by an expert, were recorded. Both videos were shot from two different perspectives. A First Person Perspective and a Third Person Perspective. In the First Person Perspective, participants could see what the expert saw when executing the simulation events. In the Third Person Perspective the events

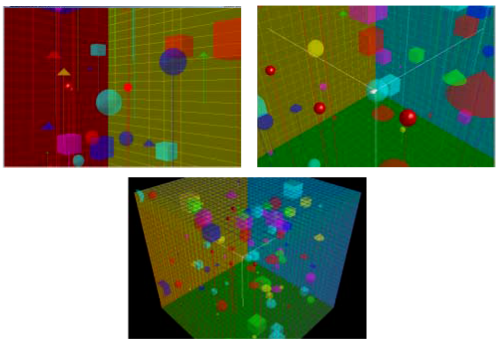

**Figure 1: Different perspectives tested in the CVE by Yang et al. Egocentric(top left) and allocentric perspectives**

were presented through the view of a roaming virtual camera. Two groups of participants were formed2. Each group was assigned one perspective. Each participant watched the corresponding video was then asked to run the simulation and complete the tasks. Additional tasks were undertaken to estimate how much the participant had learned about the simulation procedures and the spatial configuration of the environment in which they had been working. The results were positive towards the direction of using an egocentric perspective but still a lot of limitations occur on the nature of the task and further exploration is necessary.

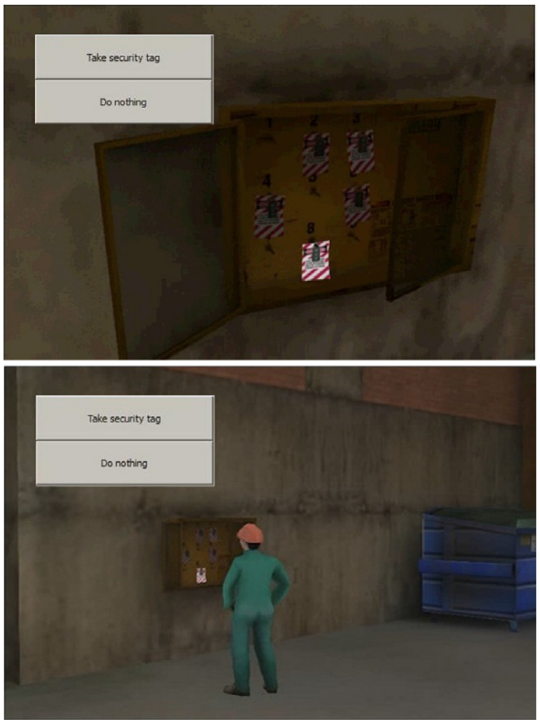


**Figure 2: First person perspective(top) and third person perspective(bottom) of the expert simulation used in [8].**

With respect to the related work, Siegler and Traxler indicate the positive value of taking someone else's perspective. The work of Yang and Lindgren put visual perspective-taking into test. Their results favor an egocentric approach.

Numerous studies have dealt with dance education and the

use of new media.

Indeed, in the study carried out by Drobny et al[4], 4 different augmented feedback methods for learning a choreography were evaluated. Those methods consist of video, written representation of the choreography, vibrotactile feedback and acoustic feedback. In general the first two methods are regarded as support methods since they do not provide feedback based on each participant's performance. Their experiment consists of four sessions:

1. Teaching session
   Participants are taught a number of choreographies.
2. Training session
   Each participant performs the choreography assisted by a support or feedback method.
3. Evaluation
   Each participant performs the choreography/ies, in several tempos, without any assistance.Each performance gets evaluated based on the amount of correct/ incorrect steps.
4. Retention test
   The same procedure took place,again, after two weeks in order to calculate long term learning effects.

Charbonneau et al [3] investigate the player experience in a dance game environment through two different media representations of dance. Either through video footage, either through visual representation of user's movement, or both together. They designed a dance game where people are required to perform a choreographic routine given either video feedback, game feedback, or both(Figure 3). They measured both the performance of each user and their experience to draw the conclusion that the users preferred both representations. When it comes to the instruction video over the visual game interface, the users tend to suggest the former. Indeed, the performance rate was higher when using the instruction video.

Virtual training systems have also been developed [13, 21]. In the former, he user is presented dance exercises to be executed and receives feedback and motivation in real time, in order to correctly perform those exercises. In the latter, a system was designed that guides a trainee in following and learning motion through a virtual reality environment. The study showed that the system was able to achieve training and transfer effects as good as conventional learning media.

Moreover, many different virtual dance environments have been introduced, like the ones mentioned in the work of Thalmann et al[10].

Owing to the results of the aforementioned studies, we were encouraged to combine the scope of perspective-taking with the art of dance and specifically the act of learning a choreography with the ultimate goal to combine the knowledge derived from this research in a virtual dance educational environment.

## 3. DANCING THROUGH VISUAL PERSPECTIVE TAKING

The aim of this study is to blend perspective-taking with the practice of learning a choreography. Through this study

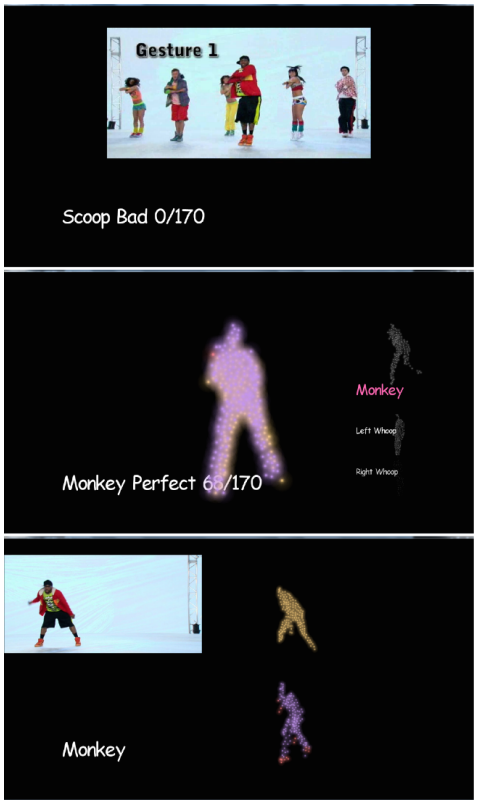


**Figure 3: The display modes used in [3] top: Video Only (Full Routine), middle:Game Visuals bottom : Both (Training)**

conclusions will be drawn about the effects of perspective taking on this field.

The research was based on the hypothesis that, when the visual perspective of someone changes, from allocentric to egocentric, he will manage to learn a choreography faster, no matter his dance experience. It is based on the belief that the level of embodiment and immersion felt from an egocentric perspective, especially through a head mounted display, would accelerate the process of learning/memorizing a choreography. The sense of embodiment in the teacher and the mental projection of his movements onto someone' s own body play an important role. According to Riva, our conceptual system produces dynamically contextualized representations (simulations) that support situated action in different contexts [12]. He regards cognition as embodied, when it can be supported by Virtual Reality environment that serves as a simulation technology of embodied concepts. In our case, an egocentric experience of dance is the embodied concept.

Moreover we would like to give answers to issues concerning the effects of the different perspectives on the performance and subjective qualitative measures regarding those perspectives.

When someone learns a task/dance from an instructor, he observes the instructor performing the particular task/dance. He tends to follow the whole task. He replicates the elements introduced in this task(steps per se), subconsciously, without making any other effort to learn or memorize it. Eventually, after much repetition of this task and following the steps, he manages to learn the task.

In an egocentric approach, embodied cognition will cause someone to identify with the person performing the task/ dance. The person from a keen observer will become part of the whole process. His intentions change. The safe choice of following someone else is not a choice any more. The person moves from the comfortable zone of an external observer to the active zone of internal action. In order to learn he needs to activate his mind and understand the different dynamics presented to him. His mind is vigilant resulting to a faster learning/memorizing of the dance.

Clearly, dance is a tricky field to test such an approach. The fact that there have been positive results of the use of visual perspective taking in a virtual environment together with the deployment of virtual dance environments [11] and networked dance applications [2, 15] raises the interest to assess the combination of these two. The nature of virtual reality and the technological evolution that comes along this field, offers the tools and the platform to further experiment on a scheme like this.

In case our assumption is proven right, such a development could enrich the methods used in teaching dance, especially in a virtual dance class environment. An egocentric view combined with a head mounted display would intensify the immersion of the user. The user will learn basic elements of choreography faster, offering more time to practice and focus on details.

In order to test our hypothesis, we are going to use a third person perspective video(allocentric perspective) and a first person view(egocentric perspective) video. The users will be invited to learn a choreography from each perspective and we will be able to collect enough data regarding our basic hypothesis and about both approaches. This data will be used to evaluate our proposed setup, in practice.

The option of an actual first person perspective, meaning actual view of a person's eyes, was considered. Such an experimental setup containing eye-tracking and video shooting to extract the actual point of view of a person, would be difficult to use. First of all because, the dancer showing the choreography would have to wear extra equipment apart from the action cam, discomforting himself while moving. Secondly, dance is a very active process that involves every kind of movement with different paces. Inevitably, vibrations propagate through the body. Thus, making the eye tracking device unstable enough to accurately track the eye movement. Finally, a point of view approach gives enough "egocentricity" to the user. Such a view, also identifies with the first person view that most of the people are familiar with in a virtual environment(games) and from action cam videos.

# 4. EXPERIMENT

To investigate the validity of our hypothesis, we designed the following experiment.

We filmed 2 different choreographies of the same difficulty level from a different perspective, each.

1. Allocentric, third person view
2. Egocentric, first person view

In the beginning of the experiment, the participants receive some general information about the experiment. The participants follow a training session that introduces them to a basic set of movements that are utilized in both choreographies. This way, they can get themselves familiar with the movements they will be asked to perform, warm up and feel more comfortable.

After the training session, the main session of the experiment follows. This session consists of two parts. In each part the research participants view a video with the teacher performing a choreography. This is an approach very similar to the traditional approach with a real teacher. Each video is shot from a specific perspective. Either allocentric or egocentric. The order of the videos is randomly chosen.

During each part of this session, the participants are required to learn/memorize the choreography. They have the possibility to play the video back, as many times as they wish, as if they get assisted by a real instructor, in order to learn the choreography. When they feel confident enough that they have learned the choreography, they are asked to perform it by memory. They are provided feedback regarding the choreography and details of it. For example, "The choreography was incorrect." or "Which leg is in the front?".

The participants have the opportunity to watch the video again in order to correct themselves. When they have successfully memorized the choreography, the time needed to accomplish this task is registered. They are then prompted to perform the choreography together with the video assistance. The final performance is filmed for documentation purposes. The collected footage will be then used to evaluate the performance of the each participant in order to extract additional qualitative measures about the performance in each case. In the case of the participant's denial to be recorded, the evaluation process took place simultaneously.

A short break is interposed between the two parts of the main session. After the break, the same process is repeated, using the second video/choreography. This way we manage to simulate and put into test the aforementioned perspectives and also guarantee that the same experimental conditions take place among all participants.

The experimental process is terminated after the completion of a qualitative questionnaire, through which we are aiming to achieve the collection of subjective data regarding our research.

Our objective is to determine a set of measures that strongly relate to the purpose of the task. For this reason, we analyze the participant's performance according to our main measures. These are the:

1. Learning time
2. Performance Evaluation
3. Questionnaire data

## 4.1 Design of choreographies

The choreographies were designed in such a way that,

1. They both shared the same level of difficulty. Since the participants were required to perform two instances of the same experiment from different perspective, the

(a)Allocentric, third person view

(b)Egocentric, first person view

**Figure 4: Screenshots of the choreographies shot in two different perspectives**

corresponding choreography should differ every time. If the choreography was the same in both test conditions, there would be an advantage for one of the two conditions.

2. They are not very complex, and small in duration.They do not involve rotations since it is neither pleasant nor easy to interpret a rotational motion in a first person view.

Both choreographies make use of the same song and are short in duration. They were filmed in a dance hall environment from two different angles 4. The allocentric perspective was shot from the back right of the dancer, as if the student stood behind watching the execution from him. The egocentric perspective was shot from an action cam located on the forehead of the dancer, to present a view similar to the one that the dancer has while dancing.

## 4.2 Participants

Seventeen people were asked to participate in this research. Eight male and nine female participants. Their dance experience ranged from novice(0 years) to expert(15 years).

## 4.3 Performance Evaluation

Concerning the evaluation of the participant's performance, we came across the following research, that developed the Performance Competence Evaluation Measure [7]. This research analyzes the design and the advantages of their proposed method. Even though PCEM is very accurate, it is getting into so much detail when it comes to evaluating the performance, thus becoming time consuming to evaluate all the recorded performances.

For this reason we decided to adopt the performance measures described in E. Charbonneau, A. Miller, and J. J. LaViola Jr. [3]. They made use of:

- Moves
  How accurately they remember and execute the moves
- Timing
  Sense of rhythm
- Flair
  How graceful and smooth movements appear

In our experiment two judges were shown the original videos of the choreography executed by the instructor. Then they were asked to judge the performance of each participant based on the aforementioned measures. The performance of each participant was based on their final execution of the choreography involving every movement.

The judges rated each performance from 0 to 10 in each category (0 being low and 10 being high). The judges were selected so that they have professional dancing experience.

## 4.4 Questionnaire

The questionnaire was carefully designed in such a way that it would incorporate meaningful qualitative measures in our research. It offers a multidimensional mapping of the participants, including age, years of experience, so that we could relate our findings with several characteristics, in order to develop an overall understanding of the situation and draw valuable conclusions. The participants were also asked to evaluate their experience in each condition and also share personal opinions that could not be measured throughout the experiment using quantitative methods.

Among other measures, the questionnaire aimed to draw light in how natural each approach felt to the individuals. Collect data about the movement awareness in each perspective and the level of confidence of the participants, while performing after being taught from different perspectives. Measures that will help us understand the differences between the two perspectives and the effects they have on the individuals' cognition.

## 4.5 Results

After the conduction of the described experiment, the available data was gathered for further analysis. Data regarding both perspectives and different measures tested during the experiment can be found in Table 1. The results are organized in groups based on the gender and dance experience.

From the group of the participants only five(29 percent) participants had previous dancing experience. Out of these five participants only one of them was male. Their experience ranged from a few months to fifteen years and they were familiar with several dance forms including, ballet, modern dance, traditional greek and chinese dances, salsa and zumba. Almost half of the participants (47 percent) were familiar with videos shot with action cameras, therefore first person view videos.

The learning times of each participant are presented in figure 5.

| | | Mean Learning Time (in minutes) | SD | *Performance* | *SD* | *Naturality* | *SD* | *Movement Awareness* | *SD* | *Confidence* | *SD* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Allocentric Approach* | *Group* | 5.9 | 1.88 | 6.02 | 1.36 | **7** | **2.18** | **7.47** | **2.45** | 6.88 | 1.97 |
| | *Male* | 4.83 | 1.11 | 5.75 | 1.14 | 6.375 | 2.67 | 6.88 | 3.27 | 6.75 | 1.98 |
| | *Female* | 6.85 | 1.95 | 6.26 | 1.44 | **7.56** | **1.59** | **8** | **1.41** | **7** | **2.06** |
| | Experienced | 6.39 | 1.6 | 7.2 | 1.44 | 7.6 | 2.19 | 8.4 | 1.82 | 7.2 | 3.03 |
| | Inexperienced | 5.63 | 2.09 | 5.53 | 1.02 | **6.75** | **2.22** | 7.08 | 2.64 | 6.75 | 1.49 |
| *Egocentric Approach* | *Group* | 5.04 | 1.91 | 5.18 | 1.6 | **5** | **1.87** | **5.47** | **2.6** | 5.94 | 1.48 |
| | *Male* | 4.59 | 1.52 | 4.96 | 1.36 | 5.88 | 1.25 | 6 | 2.83 | 6.85 | 0.64 |
| | *Female* | 5.45 | 2.21 | 5.37 | 1.96 | **4.22** | **2.05** | **5** | **2.45** | **5.11** | **1.54** |
| | Experienced | 5.72 | 3.14 | 6.07 | 1.96 | 4.8 | 2.68 | 5.8 | 2.28 | 5.8 | 1.79 |
| | Inexperienced | 4.71 | 1.25 | 4.81 | 1.34 | **2.45** | **1.56** | 5.33 | 2.81 | 6 | 1.41 |

**Table 1: Aggregated results of the experiment and the questionnaire, comparing the two perspectives. Bold values indicate significant results.**

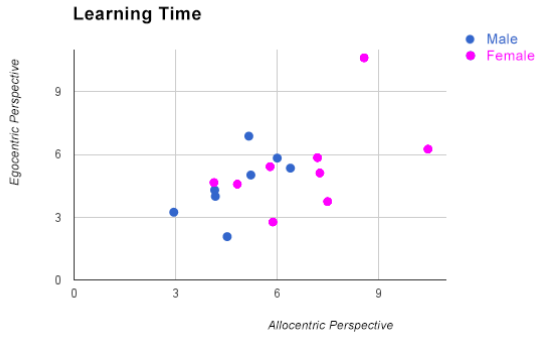


**Figure 5: Time required for each participant to learn a choreography in each perspective**

The mean time for each category and standard deviation are shown in figure 6. The mean time to learn the choreography from the egocentric perspective is smaller than the mean time to learn the choreography from the allocentric perspective. This would support our hypothesis that it is faster to learn a choreography from an egocentric perspective. Nonetheless, a one-way ANOVA analysis concludes to $F(1, 32) = 1.74$ , $p = 0.2$. Our results are not statistically significant and our hypothesis has to be rejected. There is no significant difference in how fast someone learns a choreography from the tested perspectives.

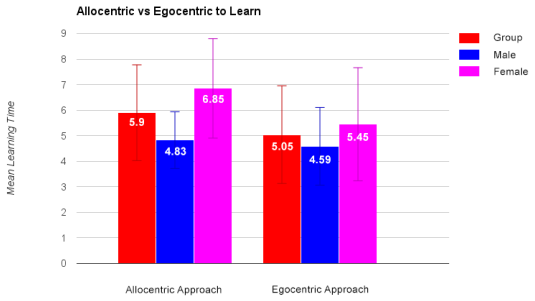


**Figure 6: Mean Time(mins) to learn a choreography in each perspective**

Similarly, the sequence of the perspectives did not play any significant role in the learning time($F(1, 15) = 1.83$, $p = 0.2$), neither did the action camera video familiarity($F(1, 14) = 0.0002$ , $p = 0.2$) and the dance experience($F(1, 8) = 0.18$ , $p = 0.68$).

$$z_i = \frac{x_i - \bar{x}}{s} \tag{1}$$

On the contrary, the participants did not feel the egocentric perspective more natural (M = 5 , SD = 1.87), compared to the allocentric perspective (M = 7, SD = 2.18). Moreover, they felt less aware of the movements (M = 5.47, SD = 2.6) through the egocentric perspective than through the allocentric (M = 7.47, SD = 2.45). Correlation analysis of how natural each perspective felt and how confident participants felt proved that the more natural a perspective seemed, the more confidence into their dance, the participants had. There was also strong correlation between the allocentric performance rating(M = 6.02, SD = 1.36) and the egocentric performance rating(M = 5.18, SD = 1.6), r = 0.76, p = 0.108, n = 17.

In figure 7, an overview of the learning times and performance of the individual participants is presented. The results have been standardized using the z-transformation (1). This method transforms all indicator values into standardized values with an average 0 and a standard deviation 1. It has the advantage to consider the heterogeneity within groups and maintain its metric information. Z-values become comparable by measuring the observations in multiples of the standard deviation of that sample. This way we can compare every individual with the mean value of each category. Their results have been arranged based on the average total learning time, from highest to lowest, in order to achieve an easier comparison among categories.

Apart from quantitative measurements, we were able to collect data regarding people's experience throughout the experiment.

Participants with no prior experience of dancing found the mirror confusing and troubled to distinguish left from right. There was also a case where the participant actually did not realize that she was looking at a mirror and followed the movements as if she had an instructor in front of her. The egocentric approach lacked in details. The instructor was placed pretty much away from the mirror, and people were not able to distinguish details.

A couple of participants with prior dance experience, stated that it was difficult for them to memorize the allocentric choreography, because they were used to follow their instructor in their dance classes and it took them some time for their mind to adapt. In a case, a participant felt that it was harder for her to memorize in the allocentric approach because she had the instructor in front of her and relied on

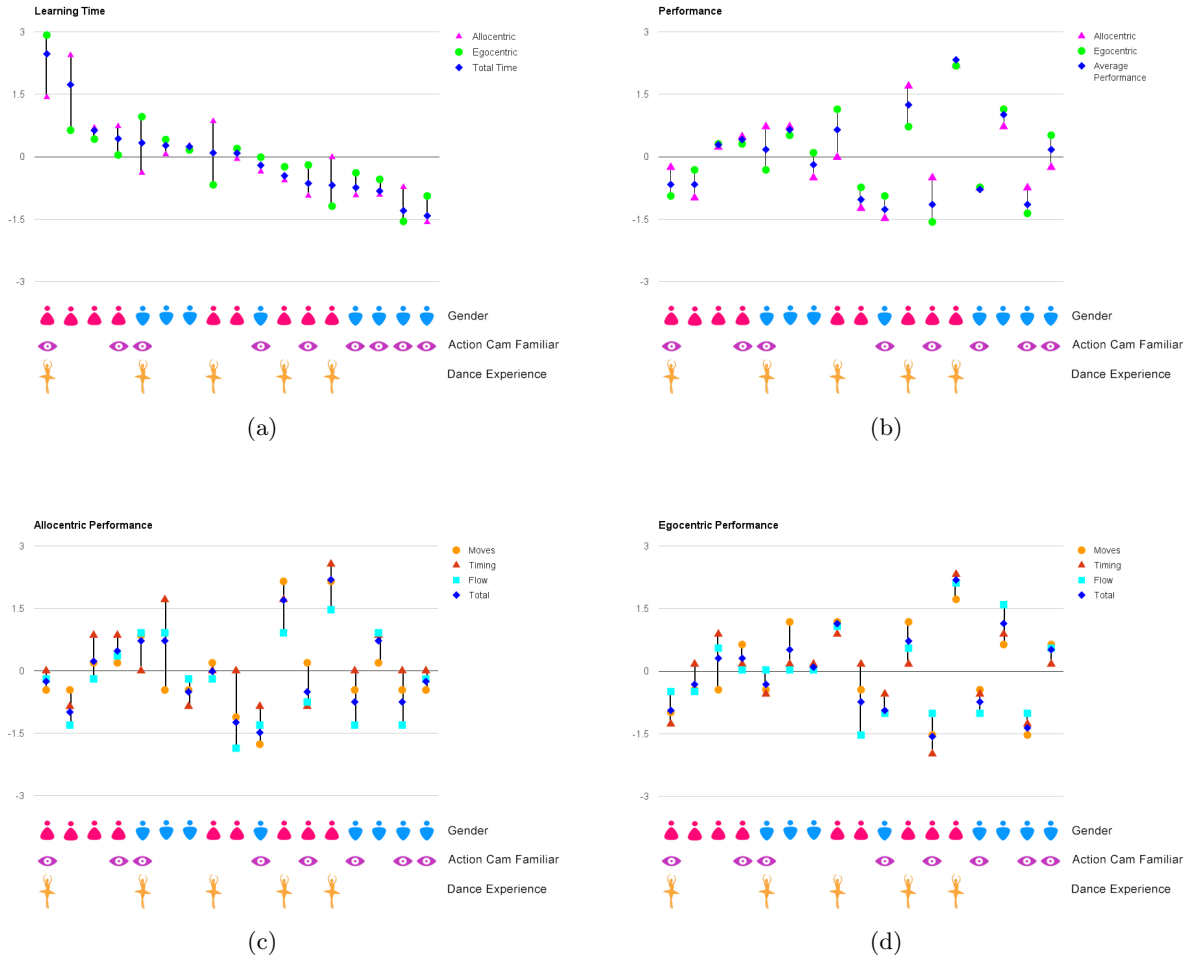


**Figure 7: Standardized Results of individual participants: (a) Learning Times (b) Performance ratings (c) Allocentric performance (d) Egocentric performance**

watching her more than trying to learn the choreography by heart.

## 5. DISCUSSION

Based on the final results of the experiment, we can deduce that there is no significant difference on how fast someone can learn a choreography when he is taught from a different perspective. Even though a large majority of participants managed to learn a choreography faster through an egocentric perspective, the sample size and nature of the experiment invalidate the initial hypothesis.

Even though an egocentric perspective is a first person view, that almost identifies with one' s own view, it did not feel natural to the participants. People seem to be more familiar with the third person view.

The gender does not play any role in how fast someone learns a choreography. The sequence of the tested perspectives did not play any role either. There were participants who believed that they did better in their first choreography because they were more focused on their goal while on the second choreography they felt more relaxed. On the other hand, there were participants that felt that they did better in their second choreography because they were more familiar with the whole experiment. Likewise, previous experience with action cam videos and dance experience does not help in learning faster through an egocentric perspective. The egocentric perspective offers limited movement awareness to the users. Considering the above reasons, we can conclude that the egocentric approach can not substitute the allocentric approach to teach dance.

Through an allocentric point of view, someone has a broader field of view. This practically means, that he can acquire a larger amount of information regarding movement, space and orientation. From an egocentric point of view one has to guess or needs some extra guidance to perform movements that are outside his field of view. If someone has a prior dance experience he can more easily relate to movements that he sees and connect his responses to them.

On the other hand, from the egocentric perspective, one does not have the safety of the teacher. He has to act and think more and try to memorize the movements instead of just following someone else passively. This can have positive effects on the time someone needs to learn/memorize a choreography, without focusing on the details of each movements.

Apart from that, we should also take into consideration the learning aspect in the human nature. People are not very familiar with a first person view, fact that was reflected on

the questionnaire. The results might have been different if they had the opportunity to train or adapt themselves into the new perspective and the proposed learning scheme. This way they could overcome several limitations that appear in this perspective or feel more confident about themselves and their movements.

In comparison with the work of R. Lindgren [8], that inspired this study, we could mention the following.

The current study failed to reach respectively positive results. This is because of the different nature of the experimental situations. In the present study, dance is a fast paced activity that includes rotations and large number of concurrent movements, whereas the videos presented in the other study were directed. They would focus on certain points/events of interest through the egocentric perspective. This way the users had the opportunity to better process the information they received.

Moreover the limited field of view and head movement hides valuable information. This was partially avoided through the use of the mirror and the design of the choreography. Nonetheless, this prevents someone from going into deep detail. Either distinguishing movement detail through the mirror or designing a choreography without any restrictions.

There is no specific knowledge passing through an expert, since there is no particular focus on elements of the choreography, that can assist people into improving their skills. However, it puts users into a procedure where they are required to assimilate information instead of just imitating movements. The absence of a person to follow, inevitably leads people into putting extra mental effort. They are situated in the epicenter and they identify themselves with person in the mirror. Hence, they seem to memorize the sequence of movements faster.

The valuable data collected throughout the experiment and the problems mentioned by the participants and observed by us, led us to reflect on several options to improve the experiment.

First of all, a wider sample of participants, or even more homogeneous, could lead to a significant result. Longer choreographies can be put into test to observe how the participants' performance would get affected. Instead of two choreographies, we could utilize only one. This way, the comparison of both perspectives is based on the same choreography. Another possibility could be to test participants' learning capacity a period of time after the first experiment.

Regarding technical or design problems that came forward during the research, we could mention the following.

The choreographies should have been recorded in a much brighter environment, so that most of the detail is visible through the video. For the same reason, the egocentric perspective could have been performed closer to the mirror, so that the details would have been more distinguishable. The use of the same song in both choreographies was also an issue. A couple of people commented that they mistook movements in the second choreography because they had associated the music with movements from the first choreography.

Furthermore, the experiment could contain a small session after the training session where participants could familiarize themselves with the two perspectives.

The experiment's location was also problematic. The absence of mirrors influences the cognition of people especially when regarding the egocentric approach, where the mirror plays an important role. It also influences their level of confidence, since they do not get any feedback. They are not able to see their moves and compare them with the moves shown by the instructor. Moreover, the lighting conditions were not controllable. This affected the brightness of the projection and, by extension, the detail level observed through it.

Participants did not feel the egocentric approach very natural. This can be due to the absence of embodiment, that was caused by the choice of presenting the egocentric instruction videos on a screen rather than a head mounted display. Using a head mounted display the participants would alienate from the external environment and focus on the egocentric perspective feeling more embodied and identified with the instructor that dances.

Despite the insignificant results, a better experimental design could lead to a more clear overview of the perspective-taking in dancing.

Such an approach could benefit the process of learning a choreography, by minimizing the time to memorize it. Giving more time to focus on the details with the use of other feedback methods, oral feedback per se.

It could be used in a network dance class, were instead of being taught through the eyes of an observer you can be taught through the eyes of the teacher. There is always the problem with spatial awareness, but it could be solved with the use of more mirrors.

The problem of high rotational movements will remain unsolved. The mind cannot process the high speed motion through the egocentric perspective, causing dizziness and deficiency of orientation.

The proposed setup could be used to learn the steps of a choreography individually, in a networked dance class. After the completion of this task, the participants can practice the choreography in common using their virtual avatars.

We also considered the possibility of testing the combination of both perspectives, in connection with the results of E. Charbonneau et al [3], where users preferred both representations. It is irrelevant with the basic hypothesis of our research, but it can give valuable data in the design of a virtual reality dance environment. This approach can be further investigated in the design of a virtual dance class environment. This way, the advantages of both representations are utilized into practice.

## 6. CONCLUSION AND FUTURE WORK

Former research in perspective-taking, has yielded positive results concerning the advantages of changing one's own perspective both cognitively and visually. Based on these results, we assumed that such a practice could be beneficial in the field of dance. Especially, during the task of learning a choreography. The use of new technology, like action cameras, gave the opportunity to test our assumption. We designed an experiment, where the participants were able to learn two choreographies from two different perspectives.

This way, we managed to measure the time they spent on successfully learning the choreographies. The results, even though they favored our assumption, were not significant.

Dance is an activity that normally takes place in the physical space. The guidance by an instructor is important, especially in the process of teaching a dance. It requires the physical presence and interaction of the related parties. A perspective-taking environment, like the one tested, lacks these qualities. Nonetheless, dance is an activity that offers plenty of space for experimentation. We are living in a world that digitalizes rapidly. That is why we envisioned a realizable application and research towards this direction.

The nature of dance, as explained in a previous section, makes it difficult to draw specific conclusions. If the activity did not involve such an intense movement, giving the possibility to concentrate on distinct points of interest the outcome would have been different.

Respecting the present study and the goals set; we can suggest the following, for future experimentation.

A better experimental design that resolves the issues discussed on the previous section would provide a more solid and accurate answer to the research question. Following this , the effects of the use of head mounted display, instead of video projection, to the users and their performance, should be investigated, in the context of dance. Moreover, ways of interactivity, between physical and virtual should be embedded in order to make it more realistic. Ultimately, we could design a networked application to teach dance, based on this method and evaluate it.

## 7. ACKNOWLEDGEMENTS

First of all, I would like to thank everyone who took part in the experiment. Their contribution was valuable to the outcome of the whole research. Then, I would like to thank Filh Dianellou for designing the choreographies and judging the performances together with Sissy Chalkia. Special thanks to Edwin van der Heide and Peter van der Putten for their guidance. Finally, I would like to thank my family and friends who stood by me and provided some insightful advice.

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