

Awareness of toddlers' initial cognitive experiences with Virtual Reality

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Abstract

In this study we used Virtual Reality technology to simulate a toddler's first few days' experiences in daycare and improve the caregiver's understanding of their state of mind. The virtual worlds were developed in accordance with the toddler's way of thinking and from her/his cognitive and visual viewpoint. The aim of the research was to investigate whether the caregiver's awareness to the cognitive experiences that the toddler undergoes in his first days in kindergarten improves through a VR simulation of a toddler's world. We simulated six cognitive elements of a toddler: object constancy; trial and error; perspective of height; perspective of things; egocentricity; and imagination. The participants in this study were 40 (female) caregivers who work with infants aged 6 months to 4 years old in private daycare. The findings indicate that experiencing a virtual world that reflects the real world of children improves the caregiver's awareness to the cognitive experiences that the toddler undergoes in her/his first days in a kindergarten or daycare.

Key words: Virtual Reality, toddler, day care, kindergarten, cognition, initial experience.

Introduction

'First experience of daycare for an infant (aged 8 months to 2 years) can be a confusing experience. The infant's world expands. S/he must come to terms with a new environment and new people—the caregivers, other toddlers. The infant must adopt different behavioral patterns from those s/he is used to at home. His/her daily timetable changes and s/he must gradually learn to give up on previous habits (Raviv and Katznelson, 1986).

When the toddler enters a new environment – the kindergarten – he experiences a childhood crisis. He is steeped in anxiety, and struggles to understand or evaluate the new situation in which he finds himself. He finds it hard to understand the new

relationships between him and his social environment, he struggles to formulate attitudes and aims, and to shape appropriate ways of behaving (Raviv and Katznelson, 1986).

The toddler's abilities to think and perceive are different from those of an adult, and they influence the way in which he will cope with adjusting to a new place. The toddler's world outlook is absolute. The infant mixes his "self" with the world, and only later does he distinguish between his private point of view and that of other individuals. The toddler believes that s/he is the center of everything that takes place, and that things always remain as s/he sees them (Piaget, 1967). Even when his thought progresses to the pre-operational stage (from 2 to 7 years), it is with difficulty that the toddler learns to see from someone else's viewpoint. His thought is concrete – things are as they seem from his direct and egocentric perception, and unsubstantial phenomena appear to him as tangible (dreams, thoughts) (Flavel, 1970).

Such patterns of perception make it difficult for the toddler to adjust to a new framework. He cannot understand why he must change his surroundings, move to a new place, and leave behind familiar faces. He is focused on the things that he has found pleasure in and that have satisfied him so far, but now, with the move to a new framework, they are taken from him. He cannot relate to his parents' considerations that brought them to introduce this change into his life and leave him with others (Piaget 1967, Freiberg 1974).

The toddler's egocentricity leads to Magi-like thoughts. He believes that his wishes, his thoughts, and the words he emits from his mouth are the tools of his Magian powers. He thinks that the actions he carries out have influence on other objects, and that he can change reality with a thought, word, or look. When the toddler is at the stage at which he believes that he is omnipotent, and that it is within his power to sway his influence over every object in his environment, his entrance into a new framework shakes this belief: suddenly events are out of his control, he does not understand them, and he is not sure that his needs will be met by strangers; feelings of fear and anxiety are awoken in him.

The assumption at the basis of this study, therefore, is that the caregiver does not possess enough awareness of the cognitive characteristics of toddlers and thus cannot appreciate the influence that the separation from his parents has over his behaviour at the beginning of the year in the kindergarten. By using three-dimensional Virtual

Reality (VR) worlds that simulate cognitive aspects unique to toddlers in their care, this study investigated whether it is possible to increase the caregiver's awareness to the toddler's cognitive experiences in his first days at the kindergarten. To the best of our knowledge, this is the first time that VR technology has been used in training toddlers' caregivers, and in simulating the cognitive experiences of toddlers.

Toddlers' VR Worlds

Virtual Reality is defined as a computer-based multimedia environment with a high level of interactivity, such that the user becomes a participant within the virtual world (Panthelidis, 1994, Bilia, 1997). Virtual Reality has a number of characteristics:

- Simulation: experience in an artificial environment that simulates a real one.
- Immersion: the user is absorbed within the virtual world, and feels as if s/he is in the real world.
- Interaction: the user, the characters, and the objects in the virtual world interact (Salis & Panteldis, 1997, Bilia 1997, Heim 1993).

For this research, an experiment was carried out with the help of a virtual world that acted according to the rules of toddlers' cognitive and emotional development, and simulated the toddler's world for the caregiver. Studies carried out in other fields have indicated that the use of simulations can help to improve comprehension in various areas (Postka 1995, Cass & Roblyer 1999).

For this study we designed 4-dimensional VR worlds in which we embedded cognitive elements from toddlers' experiences, based on Piaget's theories. The following is a description of the worlds, with an ascription of the various images to the cognitive aspects they were based upon. These VR worlds can be accessed through the Internet with a free downloadable VR plugin at (viscape) <http://faculty.biu.ac.il/~passig/vrprojects.html> (look for VR KINDERGARTEN).

1. Object Constancy

The caregiver enters a forest. Before her, she sees paths leading to further paths that lead to a house. After a few moments, different objects connected to the child's world start to fly past at speed. The objects swiftly and randomly approach and disappear. In the background, unclear sounds can be heard, interspersed with a number of clear

words. From time to time, the user sees bodily parts approach him and then recede. The user moves, and sees everything from the height of a child. The participant has to reach the house. She is not given any instructions. She needs to experience it on her own. If she finds herself unsuccessful, she must conclude that she needs to ask for assistance.

The appearing and disappearing objects and voices reflect the developmental element of object constancy, according to Piaget. Up until the age of 8 months, infants think that if a certain object disappears from sight then it no longer exists. Only when the infant is about one year old does s/he start to look for hidden objects, but even then s/he will look in the first place that the object was hidden. Only as the toddler reaches the age of two years old does s/he learn that objects that s/he cannot see still continue to exist (Flavel, 1970). As a result, the toddler feels a sense of instability, living as he does in a world in which objects and people appear and disappear, and it is not clear what is going on around him. He lives with a feeling that he lacks control over his environment (Freiberg, 1974). Searching for the house via the paths represents the way the infant experiences things and learns – by trial and error (Flavel, 1970).

Figure 1: A picture from the virtual world – the house in the forest that the user must reach.

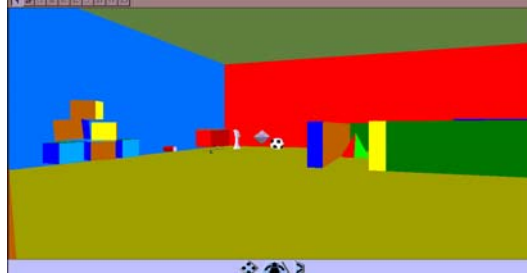


2. Trial and Error

Upon reaching the house, the participant enters a room. The room is a playroom in a kindergarten. Once more, the participant sees everything from the toddler's perspective. In the center of the room a maze appears. The participant must pass along all of the maze's paths until she reaches the exit. She must knock over the cones that she encounters along the way. Because of the change in perspective, each time the user touches a cone, it changes shape. This also relates to the element of spatial perspective (objects) – the child perceives the object differently from each angle. When the caregiver participant leaves the maze, she sees a door in front of her. She

must touch the door, and move in to the next room. The attempt to find the way through the maze reflects the way the infant experiences things and learns – by trial and error (Flavel, 1970).

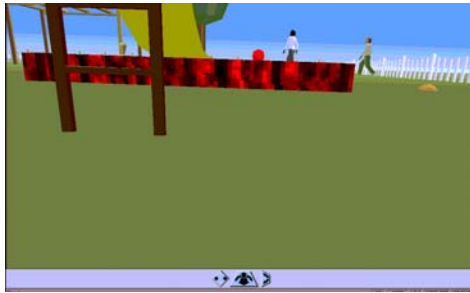
Figure 2: The maze in the virtual world's playroom as seen from outside



3. Spatial perspective – height & objects

The second room is designed like a playground. The participant can see a slide ahead of her. She is not given any instructions, and she must try to work out what to do alone, or ask for assistance. The participant must climb the ladder and slide down the slide. When she looks at the slide she can only see certain parts of the people and objects around her – she cannot see them in their entirety. After sliding down the slide, the participant will see big balls. She will struggle to catch them. The balls will roll away from her, until they disappear from her field of view, as if they no longer exist. After a number of attempts, a door will once more appear on the other side of the playground. The participant must touch the door and enter the next room. The participant caregiver's attempts at catching the elusive balls once more reflect the element of trial and error (Flavel, 1970). The rolling balls, escaping and disappearing from the user's field of vision, represent the developmental element of object constancy.

Figure 3: Part of the slide's ladder in the playground in the virtual world – view from below.



4. Imagination and Reality

In the third room, the participant can see a rug with toys on it, a vacuum cleaner and a drill. For the whole length of this room's experience, the sound of the drill can be heard. The caregiver looks around her and sees the drill in action, rotating, making an exaggerated noise, and making enormous holes. When the drill ceases to work, the vacuum cleaner comes on. At this moment its dimensions enlarge and expand, it makes noise, and sucks up every object in its path.

This experience represents the toddler's inability to fully distinguish between imagination and reality. According to Piaget, the infant tends to attribute Magian importance to his/her thoughts. The infant thinks s/he can change reality with a word or a look. He also attributes human characteristics to inanimate objects: the vacuum cleaner, for instance, can "eat" everything – objects and people (Piaget, 1967).

Figure 4: the drill in action in the virtual world's third room.



5. Egocentricity

While experiencing the virtual world, the participant wears a Head Mounted Display (HMD) and enters another world – the world of children. Throughout the experience, an effort is made to give the user the feeling that she is the center of this virtual world—everything happens around her. She is required to activate the virtual world,

otherwise, nothing happens; there are no people there other than her; everything happens only to her and not to anyone else. The participant does not receive a description of what will happen to her during the experiment, but only a general explanation, and that in order to create a feeling of expectation, curiosity, and impatience to reach the next stage. This represents the infant’s egocentricity. According to Piaget, the toddler feels as if everything that happens is centered around him, and that s/he is at the center of the world. S/he cannot see from another’s point of view, and finds it hard to delay satisfaction (Piaget, 1967).

The Research Participants

Our sample included 40 caregivers. The term “caregiver” relates to baby-minders who work with infants aged 6 months to 4 years old in different private frameworks such as crèches, or kindergartens under the supervision of the Ministry of Education.

Table 1: The sample of participants

Age	20-28 = 12	20-41 = 14	42-58 = 14	Total = 40
Education	6 did not finish high school	14 completed 12 years of K12 education	19 studied between 13-17 years	1 did not respond

Research Design

After the VR worlds had been built, and after the participants had consented to participate, the researchers scheduled personal meetings with each one of them at their convenience. The meetings usually took place in the afternoon hours, when the caregiver had finished work for the day. Two to four caregivers participated in each meeting, each of which lasted between 2-3 hours. The researchers brought the hardware and software needed to run the virtual worlds to the kindergartens in which the participants worked.

The research design included a pre-test, an experience in the VR worlds, and a post-test. The research did not include a control group because the researchers did not think a control group could have contributed to this study, since there isn’t a similar technology up to date that made an attempt to simulate any cognitive aspect of a child. the researchers did not believe that a comparison with a control group that have learned the cognitive state of mind through a video tape, for example, could have been a credible group as a control group.

Pre-Experiment Questionnaire

Each participant received a short written explanation of what was about to happen in the meeting. Each caregiver was interviewed (questions 1-4 in table 2), and was asked about her opinions as to ways in which infants cope with their entrance into a new environment, and their reactions to it. Through the interview, the caregiver's level of awareness as to the effect of the toddler's separation from his parents on his behavior before intervention was also tested.

Table 2: Interview before experiencing the virtual worlds

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1. What situations, in your opinion, can cause a child to be irritable, and not calm?
 2. A child is not without his comfort blanket and dummy for a week at the beginning of the term. How would you react? Why?
 3. A child chooses to sleep all the time. What would you do? Why?
 4. About a month after the beginning of the year, a child still regularly bursts out crying. What should be done? Why?
-

Additionally, each caregiver was asked to fill out a questionnaire (table 3) that was divided into two parts. In the first part (questions 5-14), the caregiver was asked about the toddler's way of thinking and cognitive perception of the world. The questionnaire was comprised of ten statements based on the cognitive literature on toddlers. The ten statements were divided into six elements: object constancy; trial and error; spatial perspective (height – perceiving part of an object and not all of it); perspective of things (the child sees the object differently from each angle); egocentricity (in relation to the inability to delay satisfaction); and imagination. In the second part of the questionnaire (questions 15-17), the caregiver was asked about her reactions to different behaviors on the part of toddlers, which could give expression to various sensitive situations.

Table 3: Questionnaire before experiencing the virtual world

Part 1: circle what, in your opinion, is the correct answer

5. Roy is eight months old. He is playing with a ball. The ball rolls underneath a cupboard. What, in your opinion, will Roy do? (relates to the element *object constancy*)
 - i. He will burst out crying.
 - ii. He will crawl in the direction of the ball with the purpose of retrieving it.
 - iii. He will start investigating another object nearby him.
 - iv. He will look at the cupboard and make noises asking for help
6. Dor is trying to fit a circle into the right hole. How will he learn how to correspond the shape with the right hole? (relates to the element *trial and error*)
 - i. He will ask an adult for help.
 - ii. He will keep trying until he succeeds.

- iii. Using his face and hands, he will feel the shape, and using his face and hands he will feel the hole, and that way he will learn how to match them.
 - iv. One day he will succeed in fitting the shape into the hole by chance, and will learn from his success.
7. Shai is crawling on the floor. There is a table in front of her. What is the first thing that Shai sees?
- i. Shai sees the table legs in front of her. (relates to the element *spatial perspective- height*)
 - ii. Shai sees the whole table.
 - iii. Shai still cannot notice that there is a table in front of her.
 - iv. Shai sees all the objects beneath the table.
8. Dana is one and a half years old. She is hungry and wants to eat. What will she do? (relates to the element *egocentricity*)
- i. She will indicate that she is hungry by crying out or shouting that she is hungry, and will wait until she is given food.
 - ii. She will cry and will be impatient until she is given food.
 - iii. She will listen to her mother explaining that the food is heating up right now.
 - iv. She will carry on playing until the food is ready.
9. Why does Ron cry every time the food blender is turned on? (relates to the element *imagination and reality*)
- i. Ron is an irritable child who cries at anything.
 - ii. Because that is a change that Ron is not used to.
 - iii. Ron is worried by the noise and does not understand quite what is happening.
 - iv. Ron already understands that when he cries, his mother will pick him up.
10. Dan is eating biscuits. His mother explains to him that he is about to eat supper, and that the chips are for desert. Dan disagrees, and cries. His mother explains to him why it is not good to eat chips now. Dan continues to cry. Why? (relates to the element *egocentricity*)
- i. Dan is used to receiving everything here, now, and immediately.
 - ii. Dan loves chips and other sweet things.
 - iii. Dan knows that he wants to eat chips now, and is unable to comprehend that if he keeps on eating chips, he will have no appetite for supper.
 - iv. Dan cannot wait patiently for desert.
11. Shirley is one year old. She is playing with building blocks. She sees that one of the blocks has fallen underneath the table. What is Shirley able to do? (relates to the element *object constancy*)
- i. Shirley will crawl in the direction of the block and look for it.
 - ii. Shirley will forget about that block and will continue playing with the other blocks.
 - iii. Shirley will burst out crying and call for help.
 - iv. Shirley will knock the other blocks under the table too.
12. Dan's mother is standing near Dan. Dan is sitting on the rug. What does Dan see? (relates to the element *spatial perspective- height*)
- i. His mother.
 - ii. His mother's legs.
 - iii. Dan is busy flipping through his book.
 - iv. Dan does not see anything in particular.
13. Tal is playing with building blocks. She is turning a block over from side to side. Does the block look the same to Tal each time? (relates to the element *spatial perspective - objects*)
- i. Yes.
 - ii. No.
14. Dana heard her grandmother say that the ants in the cupboard will eat everything. What might Dana think? (relates to the element *imagination and reality*)
- i. That the ants will eat the food in the cupboard.
 - ii. That the ants will eat the food, her grandmother and her.

- iii. That the ants are hungry.
- iv. That the ants must be fed.

Part 2: answer the following questions.

- 15. A child is attached to the comfort blanket he has been bringing from home for a month, and is not prepared to be separated from it. Does this require a reaction? If so, what would you do? Why is he behaving like this?
 - 16. A child starts screaming every time someone approaches him. What would you do? Why is he behaving like this?
 - 17. A child is throwing things in every direction. How would you act? Why is he behaving like this?
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Virtual Experience

After completing the questionnaire, the researchers explained to the caregiver that she is about to enter a child’s world. She must put on the helmet, and adjust the eye-piece so that she sees well. Also, she is given an explanation as to how to use the joystick. It is made clear to the caregiver that no explanations or instructions will be given during the experiment, and that if she wants to know what to do, she must ask for help from the researchers (figure 5).

Figure 5: A participant wearing the Head Mounted Display and using the joystick whilst experiencing the virtual world.



The entire “experience” is a journey into four VR worlds—a forest, a playroom in a kindergaretn, a playground, and a vacuum cleaner and a drill moving in another room. Altogether create a VR experience. The participant had to stroll through the rooms without assistance. The length of this VR experience for each participant was 10 minutes approximately in which she has experienced the 4 worlds.

Many of the caregivers struggled to get by in the virtual world using the joystick. Very few asked for help, even when they did not know what to do in each room in the virtual world. The researchers were forced to remind them that they can ask for help.

With the researchers' verbal help, the participants succeeded in finishing the experience. The caregiver's need to ask for external help during the experiment in order to get by in the virtual world gave her a real feeling of helplessness, frustration and the need for help in a new place.

Post-Experiment Questionnaire

Immediately after the experiment, the caregivers were interviewed. They were asked about their feelings during and following their experience.

Table 4: Interview after the experience in the virtual world

18. You have just had an experience that you have never had before. With the help of the HMD, you entered a children's world inside a computer. You were asked to do various activities. Tell us how you felt?
19. After undergoing this new experience, how do you think you will plan the intake of a new child into the kindergarten? How will you help him to settle in and adjust?

Each caregiver was also asked to complete a questionnaire (table 5, questions 21-30), in which she was asked about the toddler's way of thinking and cognitive perception of the world, and her reactions to different behaviors on the part of toddlers.

Because no appropriate questionnaires could be found in the literature, we prepared the questionnaires for this research. These questionnaires were compiled with the help of child and technology experts. Those experts deemed the questionnaires suitable for checking the aims of the research.

Table 5: Questionnaire after experiencing the virtual world

Part 1: circle what, in your opinion, is the correct answer

21. Gal is sitting on the floor. In front of her is a ladder. What is the first thing that Gal sees? (relates to the element *spatial perspective- height*)
 - i. Gal sees the whole ladder.
 - ii. Gal sees the ladder's legs and its first rung.
 - iii. Gal still cannot notice that there is a ladder in front of her.
 - iv. Gal sees the chair behind the ladder.
22. Shirley is playing in the bath. The water is getting cold and her mother explains that she has to wash herself. Shirley refuses and cries. Why? (relates to the element *egocentricity*)
 - i. Shirley knows that she wants to play in the water now. She is unable to comprehend that if she continues to play in the water, the water will cool down and she might catch a cold.
 - ii. Shirley is used to doing what she wants.
 - iii. Shirley does not like to wash.
 - iv. Shirley likes playing in the water.
23. Jonathan is seven months old. He is playing with building blocks. The red block rolled under the rug. How do you think Jonathan will behave? (relates to the element *object constancy*)
 - i. He will be angry and cry.

- ii. He will continue to play with the other blocks.
 - iii. He will try to crawl in the direction of the red block with the aim of getting it.
 - iv. He will point towards the place that the block is hidden in, and cry for help.
24. Why does Dor cry every time his mother turns on the hairdryer? (relates to the element *imagination and reality*)
- i. Dor already understands that when he cries his mother comes to him and hugs him.
 - ii. Dor is irritable and cries at anything.
 - iii. Because it is an object that Dor is not familiar with.
 - iv. Dor is worried by the noise and does not understand quite what is happening.
25. Dave is trying to throw a hoop onto a stick. How will Dave learn how to throw the hoop? (relates to the element *trial and error*)
- i. Using his face and hands, he will feel the shape of the hoop, and using his face and hands he will feel the shape of the stick, and that way he will learn.
 - ii. He will keep trying until he succeeds.
 - iii. He will ask an adult for help.
 - iv. One day he will succeed in throwing the hoop onto the stick by chance, and will learn from his success.
26. Gad is one year old. He is hungry and wants to eat. What will he do? (relates to the element *egocentricity*)
- i. He will play quietly until the food is hot.
 - ii. He will cry and be impatient until he is given food.
 - iii. He will listen to his mother explaining that the food is heating up right now.
 - iv. He will indicate that he is hungry by crying out or shouting that he is hungry, and will wait until he is given food.
27. Eden is playing with sticks. She rolls the sticks and turns them over. Do the sticks look the same each time? (relates to the element- spatial perspective *objects*)
- i. Yes.
 - ii. No.
28. Ofir heard his father say that their vacuum cleaner vacuums everything. What might Ofir think? (relates to the element *imagination and reality*)
- i. That the vacuum cleaner will vacuum the dust that has accumulated on the carpet.
 - ii. That the vacuum cleaner cleans the carpet.
 - iii. That the vacuum cleaner will vacuum his father, him, and the dirt.
 - iv. That the vacuum cleaner is broken.
29. Maya is one and quarter years old. She is playing with a hoop. The hoop has rolled underneath the sofa. What is Maya capable of doing? (relates to the element *object constancy*)
- i. Maya will go to the sofa and look for the hoop underneath it.
 - ii. Maya will forget about the hoop and look for another game.
 - iii. Maya will burst out crying and call for help.
 - iv. Maya will roll other hoops underneath the table.
30. Tom's father is standing beside him. Tom is one and half years old. Tom is sitting on the rug. What does Tom see? (relates to the element *spatial perspective- height*)
- i. His father.
 - ii. Tom sees nothing in particular.
 - iii. Tom sees his father's legs.
 - iv. Tom is busy playing with the ball.
-

Results

We assumed that caregivers are not sufficiently aware of the difficulties a child goes through in separating from his parents in his first days at the kindergarten.

We also assumed that caregivers are not aware of the influence that the toddler's cognitive development has over the process of separation. This assumption was tested and confirmed in the pre-experiment interview and questionnaire.

Each caregiver was asked seven questions that allowed her to attribute the child's behavior to his separation from his parents (interview 1-4) (questionnaire 15-17).

From the answers we received, the caregivers only related to the issue of separation in three out of the seven questions (questions 1, 4, 16).

1. 23 out of the 40 respondents (57.5%) related to the issue of separation once or twice in one of those three questions.
2. 17 respondents (42.5%) did not refer once to the issue of separation.

In the other four questions (questions 2, 3, 15, 17), none of the respondents related to the issue of separation as a possible reason for the child's behavior.

The questionnaire and interview carried out before the caregivers' experience in the virtual world confirmed the assumption that their awareness of the emotional and cognitive experiences that the toddlers undergo during their first days in the kindergarten was indeed low.

Based on this assumption, the hypothesis posited by this study was that experience of a toddler's virtual world would improve the caregivers' awareness of the toddler's cognitive experiences during his first days in kindergarten.

This hypothesis was tested through the ten statements (statements 5-14 in the pre-experience questionnaire, and statements 21-30 in the post-experience questionnaire) that relate to the child's cognitive development. In checking this hypothesis, the element of separation was treated as a confounding variable.

Awareness of the child's Cognitive Stage

An analysis of the answers given by the 40 caregivers before and after their experience in the virtual worlds led to the following findings:

- The number of correct answers varied between 3 and 8, with a possible range of 0 (no correct answers) to 9 (all answers correct). Questions 5 and 11 (in the questionnaire before the experience) and questions 23 and 29 (in

the questionnaire afterwards) were united to form one question (for each questionnaire), with only a correct answer in both of the questionnaires indicating an understanding of the concept of object constancy. Up until the age of 8 months, infants think that if a certain object disappears from sight then it no longer exists. Only when the infant is about one year old does s/he start to look for hidden objects. This also occurs stage by stage. Questions 5 and 11 in the pre-questionnaire, and questions 23 and 29 in the post questionnaire (in each questionnaire apart) introduced different stages in the development of the “object constancy” concept. This is the reason that only two correct answers indicate that the participant grasped the concept. In order to verify whether the respondent understood the meaning of the concept of object constancy, there had to be two questions relating to different ages, and to the development undergone as the toddler grows from a young age to an older one.

Taking differences in levels of awareness of the effect of separation into account, we found a notable improvement in the respondents’ understanding of the child’s cognitive development after they had been through the virtual worlds experience (tables 6-7). Before the experience, the average number of correct answers was 5.3, with a standard deviation (s.d.) of 1.39. After the experience, the average number of correct answers was 6.1, with s.d.=1.51. These differences are significant for $p < 0.01$, $f = (8.18) (1, 38)$ (table 7).

Table 6: The improvement in the understanding of the child’s cognitive development, taking differences in levels of awareness of the effect of separation into account.

	Average	S.d.
Before the experience	5.3	1.39
After the experience	6.1	1.51

Table 7: Repeated Measurement analysis, while taking into account the effect of separation in relation to understanding the toddler’s cognitive development.

	Sum of squares	Degrees of freedom	F
After time	19.88	1	19.33 ***
After time * separation factor	8.41	1	8.18 **
Error	39.07	38	

*** $p < 0.001$ ** $p < 0.01$

- 20 of the respondents (50%) showed an improvement of one to four questions. With 13 respondents (32.5%) there was no change. 7 of the respondents (17.5%) expressed a deterioration of awareness in one or two questions.
- Amongst the 17 respondents who were not aware of the effect of separation there was an improvement of 12 points (70.6%), as compared to 8 points (34.8%) amongst the 23 respondents with some kind of awareness of the effect of separation.

The ten questions that tested understanding of cognitive development in children tested six elements of cognitive development à la Piaget: object constancy; trial and error; perspective of height; perspective of things; egocentricity; and imagination. Each element was tested separately, while the element of separation was treated as a confounding variable.

- Following the experience (table 8), 7 respondents (17.5%) showed an improvement in their awareness to object constancy of the child. 4 out of the respondents (23.5%) who revealed an improvement were not aware of the effect of separation, as compared to 3 respondents (13%) out of the 23 who had some level of awareness of the effect of separation. The differences were not found to be significant.

Table 8: The differences in understanding the element of object constancy, while taking differences in levels of awareness of the effect of separation into account.

Object constancy		Have some awareness of the effect of separation (N=23)		Have no awareness of the effect of separation (N=17)		Total	
		%	N	%	N	%	N
	Improvement	13.0	3	23.5	4	17.5	7
No improvement	87.0	20	76.5	13	82.5	33	

- Following the experience (table 9), it was found that 29 of the 40 respondents (72.5%) revealed no significant change in their awareness to the element of trial and error. Respondents who answered correctly before the experience also answered correctly afterwards, and vice versa. Further, we found that no significant change in their awareness to the element of trial and error took place amongst the 11 respondents (64%) who revealed

no awareness of the effect of separation, as well as amongst the 18 respondents (78.3%) who did have some level of awareness to it.

Table 9: The differences in understanding the element of trial and error, while taking differences in levels of awareness of the effect of separation into account.

Trial and error		Have some awareness of the effect of separation (N=23)		Have no awareness of the effect of separation (N=17)		Total	
		%	N	%	N	%	N
		Improvement	21.7	5	36	6	27.5
No improvement	78.3	18	64	11	72.5	29	

- After the VR experience, an improvement was found in 12 respondents (30%) in their awareness to the element of the child’s perspective of height (table 10). Further, we found an improvement in the 5 respondents (29.4%) out of the 17, who revealed no awareness to the effect of separation. The same level of improvement was also found in the 7 respondents (30.4%) out of the 23 who did show some awareness to the element of child’s perspective of height before the VR experience. The differences were not found to be significant.

Table 10: The differences in understanding the element of perspective of height, while taking differences in levels of awareness of the effect of separation into account.

Perspective of height		Have some awareness of the effect of separation (N=23)		Have no awareness of the effect of separation (N=17)		Total	
		%	N	%	N	%	N
		Improvement	30.4	7	29.4	5	30
No improvement	69.6	16	70.6	12	70	28	

- Following the VR experience, 8 respondents (20%) improved their awareness to the element of perspective of objects (table 11). Further, 5 respondents (29.4%) out of the 17 who showed no awareness of the effect of separation revealed improvement in their awareness of the perspective of objects. The same was with the 3 respondents (13%) of the 23 who did show some awareness of the element of the child’s perspective of height before the experience. The differences were found to be significant for $p < 0.05$, $f = (4.03, (1, 38))$ (table 12).

Table 11: The differences in understanding the element of perspective of objects, while taking differences in levels of awareness of the effect of separation into account.

Perspective of objects		Have some awareness of the effect of separation (N=23)		Have no awareness of the effect of separation (N=17)		Total	
		%	N	%	N	%	N
		Improvement	13.0	3	29.4	5	20
No improvement	87.0	20	70.6	12	80	32	

Table 12: Repeated Measurement analysis, while taking into account the effect of separation in relation to understanding the element of perspective (objects).

	Average of squares	Degrees of freedom	F
After time	0.73	1	5.3 *
After time * separation factor	0.55	1	4.03 *
Error	38	5.24	

* $p < 0.05$

- Following the VR experience, 13 respondents (32.5%) improved their awareness of the element of egocentricity (table 13). Further, an improvement was found in the 8 respondents (47.1%) out of the 17 who showed no awareness of the effect of separation, as compared to the 5 respondents (21.7%) of the 23 who did show some awareness of the element of the child's perspective of height before the experience. The differences were found to be significant for $p < 0.05$, $f = (4.2, (1, 38))$ (table 14).

Table 13: The differences in understanding the element of egocentricity, while taking differences in levels of awareness of the effect of separation into account.

Egocentricity		Have some awareness of the effect of separation (N=23)		Have no awareness of the effect of separation (N=17)		Total	
		%	N	%	N	%	N
		Improvement	21.7	5	47	8	32.5
No improvement	78.3	18	52.9	9	67.5	27	

Table 14: Repeated Measurement analysis, while taking into account the effect of separation in relation to understanding the element of perspective (objects).

	Average of squares	Degrees of freedom	F
After time	1.41	1	4.9 *
After time * separation factor	1.21	1	4.2 *
Error	10.97	38	

* p<0.05

- Following the VR experience, 18 respondents (45%) improved their awareness of the element of imagination (table 15). Further, an improvement was found in the 10 respondents (58.9%) out of the 17 who showed no awareness of the effect of separation, as compared to the 8 respondents (34.7%) of the 23 who did show some awareness of the element of the child's perspective of height before the experience. The differences were not found to be significant.

Table 15: The differences in understanding the element of imagination, while taking differences in levels of awareness of the effect of separation into account.

Imagination		Have some awareness of the effect of separation (N=23)		Have no awareness of the effect of separation (N=17)		Total	
		%	N	%	N	%	N
		Improvement	34.7	8	58.9	10	45
No improvement	65.3	15	41.1	7	55	22	

In summary, the caregivers' awareness of the elements of perspective of objects and egocentricity in toddlers improved, while considering differences in levels of awareness of the effect of separation as a confounding variable. Apart from trial and error, non-significant improvements were found in relation to the other elements.

We took further caution in testing the hypothesis by asking the following direct question in the interview after the VR experience: Having undergone this new experience, how will you relate to a child new to the kindergarten?

An analysis of the answers revealed the following:

- 25 of the respondents (62.5%) reported some change in their attitude to children new to kindergarten. This finding is significant for p<0.001, t=(8.0, 39).

- 22 of the respondents (88%) who, following the experience, reported some change in their attitude to children new to the kindergarten, pointed to changes connected to cognitive aspects. They used terms like: to interact with the child at its own height; to try and understand the child; not to interrupt the child; to explain; to see things from a child's point of view; to reduce the number of stimuli; to lower objects to the child's level; to understand that the child only sees parts of the object; to adjust their expectations.
- 13 of the respondents (59.1%) related only to cognitive aspects, while 9 (40.9%) talked about emotional aspects as well.
- The element of height was the most profound cognitive change reported. 17 (68%) of the 22 respondents mentioned one or two changes connected to the element of height.

Our hypothesis was strengthened by this research. Through the technological experience of Virtual Reality, the caregivers' awareness of the toddler's cognitive experience in his first days at the kindergarten was improved, while taking differences in levels of awareness of the effect of separation into account as a confounding variable. The most serious improvements were found in relation to the elements of perspective of objects, and egocentricity.

The caregivers' awareness of the toddler's cognitive experience in his first days at the kindergarten improved more amongst those who were not aware of the effect of separation.

Discussion

The correlation between the caregiver's education and the personal maturity of the toddler is not new to the literature (Kontos 1992). Nor is it new to say that training has a positive influence on the caregiver's behavior, and the quality of her teaching (Henry 1996).

However, generally speaking, a large percentage of caregivers in day nurseries have received no pedagogic training. A small minority of them has received minimal training for work with infants, while those who have received training tend to fill management, supervisory or training positions (Levin 1993). Furthermore, the worker

turnover rate in care-giving institutions is higher than in other educational frameworks.

According to a recent report, the situation, at least in Israel, is dire (Yanai 1992). One can count many reasons for this gloomy situation. The most important are the chronic shortage of manpower, unattractive salaries, and the expenses of in service training (Spodec, Saracho & Davis, 1991).

Indeed, this study confirmed that the caregivers' awareness to the cognitive experiences of an infant attending the initial days in day care is low. Based on this assumption, the purpose of this research was to test whether using advanced technology such as Virtual Reality to train caregivers would make an impression on the caregiver, and influence her attitude with toddlers. The research aimed to test whether a very small time investment (10 minutes in the toddler's virtual worlds) would produce significant training results for the caregivers.

To the best of our knowledge, this is the first research project to report positive results for such a hypothesis. Many other studies have proved the effectiveness of Virtual Reality in other training situations, but our review of the literature did not reveal any use of VR with cognitive and emotional aspects related to toddlers.

All the more so, we couldn't find any reliable tool in the literature in order to carry on this research. Therefore, we investigated with different "childhood experts" the feasibility to draft a list of questions that will represent (somehow) the toddlers' cognitive way of thinking. It was quite an experience to draft this list. The "experts" (faculty members of the Baker Center for Early Childhood Education, School of Education, Bar Ilan University <http://www.biu.ac.il>) recommended a short list that will be simple enough for the participants to follow. We believe that for an initial attempt to simulate the cognitive state of a toddler and test its efficiency, this can be satisfactory, if not to clearly indicate the efficiency of the VR technology to enhance the awareness of the caregivers to the toddlers' cognitive experience, then at least at observing evidence that count for a trend.

Following the exercise in the virtual worlds, the most noteworthy improvement in the caregivers' awareness was in relation to the cognitive elements of perspective (objects) and the toddler's egocentricity.

It could be that the improvement in understanding the toddler's egocentricity (according to which the toddler feels that s/he is at the center of the world) stems from

the caregiver's feeling as she enters the virtual world, in which she is at the center, with everything happening around her. She had to activate this virtual world, to operate and manipulate objects. It could well be that an experience in which everything that happens is dependent only on her strongly emphasizes her awareness of egocentricity. The literature offers examples of users of Virtual Reality who reported similar feelings, and who were influenced by the sensation of being at the center (Bricken & Byrne 1992, Shapiro & McDonald 1992).

Similarly, a possible explanation for the improvement in the caregivers' awareness of the toddler's cognitive element of perspective could also lie in the very way that the virtual world was built. In the playroom was a maze. The caregiver had to find her way through it, and to knock over cones that appeared along the way. Each time she touched a cone its shape would change to reflect the observer's different perspective on it. This element is particularly striking in the virtual world because the colors in it are so vivid.

The levels of awareness of the cognitive experiences a toddler undergoes in his first days at the kindergarten improved most significantly amongst those caregivers that showed the least understanding of the element of separation. This was also the case in relation to awareness of the various elements of the child's cognitive stage, apart from the elements of trial and error and perspective (height). For these elements, there were no significant differences in levels of improvement between caregivers who demonstrated different amounts of awareness before the experience.

The explanation for this could be that there were differences in levels of awareness of the cognitive experiences a toddler undergoes in his first days at the kindergarten between caregivers according to their level of awareness of the effect of separation. The caregivers with lower understanding of the effect of separation also exhibited lower awareness of the cognitive experiences a toddler undergoes in his first days at the kindergarten when compared with those caregivers who from the outset demonstrated some level of understanding of the effect of separation. From this it would follow that the effect of the experience in the virtual world was stronger for those caregivers who were unaware of the effect of separation.

That there was no difference in the influence that the virtual world had on the caregivers, according to their prior awareness in relation to the element of perspective (height), could be explained by the fact that that element is particularly strongly built-

in to the very format of the virtual world, such that it cannot be ignored. Indeed, its influence was very high on all caregivers, regardless of their awareness of the effect of separation. Concerning the element of trial and error, no improvement was noted in any of the caregivers, regardless of their awareness of the effect of separation.

Conclusion

The results of this research are by no means final, since without VR we would have had no means at all of getting the material across to the caregivers, apart from the conventional, lengthy, wearisome and expensive way – with words. This type of research opens a new path into uncharted territories—worlds that we could not easily and quickly touch and demonstrate. As opposed to other research projects using Virtual Reality, this research did not simulate situations or worlds familiar to us, but rather created abstract scenarios from a human brain, and tested the efficiency of another person's interaction with it. This study tested the immediate change in the caregivers' attitude. Further research should be conducted to test the long-range effect of VR on their behavior. Nonetheless, this research offers tools and hope for educators that they may be able to understand what is happening in the worlds of those children under their responsibility.

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