# Does the Exploratorium Evoke Emotion?

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**Abstract**
In this paper we describe a virtual reality (VR) environment, the Exploratorium, which was developed within the EU funded project EMMA (http://www.emma.upv.es/), and was designed to encourage self-directed exploration of emotions in learning how to handle different moods. It consists of three levels, each designed to generate a different mood. One main idea behind the Exploratorium is to evoke different kinds of emotions in different areas, and when the user explores and experiences these areas she recognizes, becomes aware of and gets in touch with her own feelings and emotions. The article starts by describing the theoretical background behind the environment, followed by a description of the environment (The Exploratorium) and the interaction device (The Body Joystick). We also report a first pilot study of the emotional aspects of the environment and the interaction device. The article ends with conclusions from the pilot study and a discussion about future work with the Exploratorium.

**Keywords**: Emotion, Mood, Feeling, Mood device

## Introduction

Imagine waking up on a Sunday morning. You are totally relaxed and have a lingering feeling of warmth and happiness, maybe from a beautiful dream. You start making plans for the day, perhaps you'll go on a picnic in the park, or just on a stroll along the river. Whatever happens you are going to enjoy your day off from work. After snuggling the pillow a bit longer you get out of bed, walk up to the window and pull the curtains open. It's a hazy, grey and gloomy day outside. And suddenly you feel deflated. Your day doesn't seem as fun any more and all you want to do is get back into bed and pull the covers over your head. You are in a bad mood.

We seem to be able to experience a number of mood changes even within the same day, and factors such as the weather and the surroundings can influence our mood state and induce a variety of feelings and emotions. New information technology has shown great potential in evoking both feelings and emotions in users. Many computer games are very successful in engaging the player in this way. Virtual reality can in this context be a suitable area for manipulating environmental variables and create different atmospheres in order to induce various feelings and emotions, and also enhance or even generate mood states in the user.

In this paper we describe a virtual reality (VR) environment, the Exploratorium that was developed within the EU funded project EMMA (http://www.emma.upv.es/), and which is designed to encourage self-directed exploration of emotions in learning how to handle different moods. It consists of three levels, each designed to generate a different mood. One main idea behind the Exploratorium is to evoke different kinds of emotions in different areas, and when the user explores and experiences these areas she recognizes, becomes aware of and gets in touch with her own feelings and emotions. One of our hypotheses is that the user after practice in the Exploratorium will learn to some degree how to control her feelings and to stay in balance with herself. The main aim is that, in that way, she will be better able to act in everyday life by getting a harmonic balance between body and soul.

This article starts by describing the theoretical background behind the environment, followed by a description of the environment (The Exploratorium) and the interaction device (The Body Joystick). We also report a first pilot study of the emotional aspects of the environment and the interaction device. The article ends with conclusions from the pilot study and a discussion about future work with the Exploratorium.

**Mood and emotion**

Emotion and mood are very important constituents in order to create interesting, engaging and educational virtual environments. New technology can create emotionally- arousing sensations in the user in order to produce motivation and interest. But too much emotion can give rise to the opposite effect.

In this paper we define *emotion* as having the properties of a reaction: it often has a specific cause, a stimulus or preceding thought, it is usually an intense experience of short duration - seconds to minutes - and the person is typically well aware of it (Bower and Forgas, 2000). A *mood*, on the other hand, tends to be more subtle, longer-lasting, less intensive, more in the background (Zimmermann, Guttormsen-Schär, Danuser, Gomez, 2003). The most common conceptualization of mood defines it in the two dimensions valence (degree of pleasantness) and arousal. (Watson and Tellegen, 1985; Russel et al. 1989) With this definition one can identify five different moods: high valence and high arousal (HVHA); high valence and low arousal (HVLA); low valence and low arousal (LVLA); low valence and high arousal (LVHA); and neutral (medium valence and medium arousal). See Figure 1. Specific emotions

can also be described by their valence and arousal properties. Morris (1995) provides valence and arousal scores for a number of emotion adjectives, such as carefree (HVLA) and terrified (LVHA). In this view specific emotions can be related to specific moods, based on their valence and arousal properties.
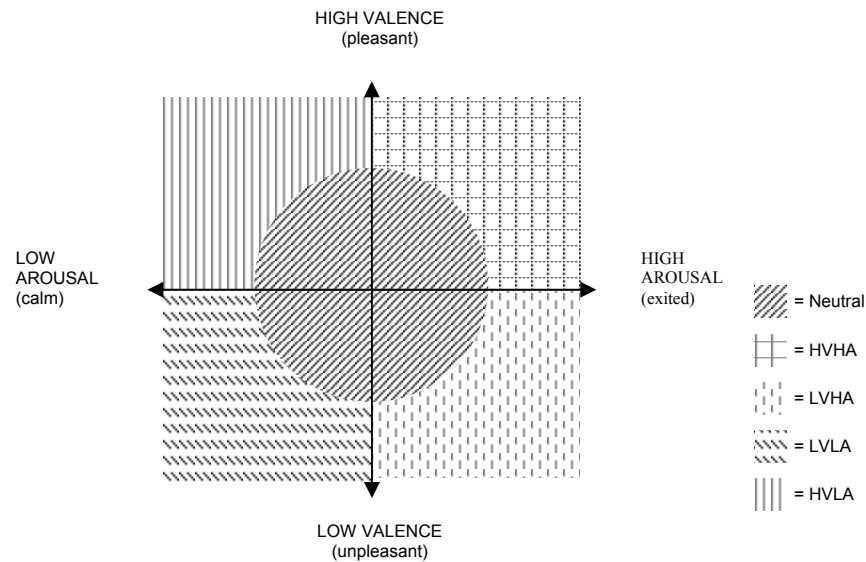


**Figure 1**, Valence and arousal space divided into five distinct mood states.

The three zones of the Exploratorium are designed to enhance or even generate three different moods. Paradiso is intended to mainly generate a light mood comprised of high valence and low arousal, Purgatorio to generate a neutral mood, whereas Inferno is supposed to generate a dark mood, consisting of low valence and high arousal. See Figure 2. These zones are also intended to evoke emotions related to each mood.
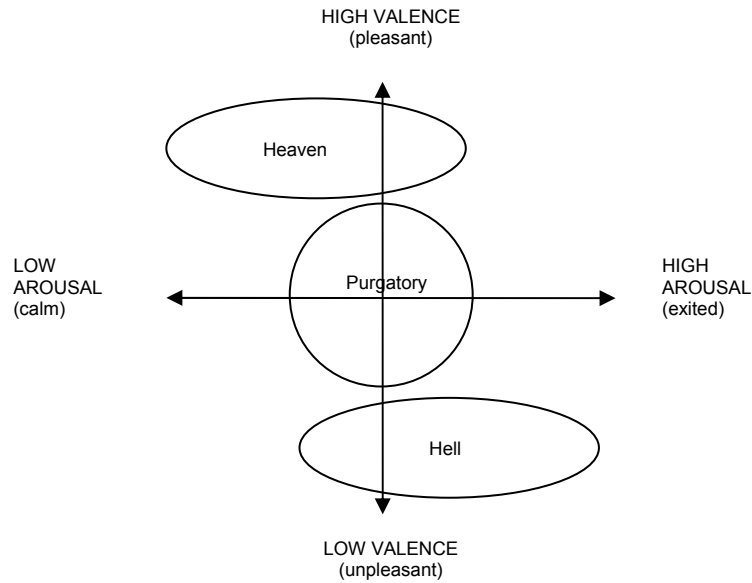
HIGH VALENCE
(pleasant)

Heaven

LOW
AROUSAL
(calm)

Purgatory

HIGH
AROUSAL
(exited)

Hell

LOW VALENCE
(unpleasant)

**Figure 2**, The intended emotional experience, in valence-arousal space, of the three zones of the Exploratorium.

There are several methods for measuring emotion and mood state, which roughly can be divided into three categories: physiological, psychological and behavioural. In the this pilot study the main interest is if moods are enhanced or even generated in the VE and if so what kind of moods are evoke in the different zones. We are also interested in which specific emotions that comprise these moods. An additional interesting question is whether the user's experience with one of the features of the body joystick, namely the use of breathing for vertical navigation feels natural and if it affects the experience in some way. For these reasons we are using psychological and behavioral measures, comprised of post-test pictorial and verbal self-rating scales, and video recordings of behavioral reactions.

**The Exploratorium**

The Exploratorium is intended to offer a virtual environment within which immersants can explore both places and feelings. It could be viewed as an environment for the user to learn, experience and enhance her own emotions and feelings. The "narrative" it implements is structural/architectural rather than linear/story telling. What happens there depends on what the immersants do in terms of navigation; if they don't do anything, nothing will happen. Different areas of the Exploratorium present different experiences: scary, normally busy, or

very calm. At the same time, the Exploratorium as a whole is fundamentally safe, a self-contained play area. Immersants can, if they wish, experience the more challenging parts or remain in the more relaxing ones. They are free to explore the different areas, under their own control.

The goal of the Exploratorium is to stimulate curiosity, leading to exploration and a consequent sense of control and empowerment, at the same time as the user experiences, explores and investigates her own feelings and emotions. We have chosen to limit interaction to navigation. Immersants are not able to select or move objects in the space, only to move around using the "body joystick" (see below) as navigation device. We thus emphasise exploration, and it is important that the Exploratorium should evoke enough curiosity in immersants so that they become self-motivated to explore.

The space is arranged in such a way that it relates metaphorically to mood or feeling state. The idea is that immersants can navigate between different zones within the Exploratorium and encounter surroundings that suggest, and even provoke, particular emotional states. The Exploratorium differs from most virtual environments in that it emphasizes the vertical dimension of navigation as well as the horizontal. In addition to visual features, the Exploratorium contains sound effects and music appropriate to each part. Upward movement suggests improving or lightening mood (HVLA), whereas downward movement corresponds to deteriorating or darkening mood (LVHA). This rather obvious linking can be theoretically supported by, for example, the Experiential Realism of Lakoff and Johnson (e.g. 1980, 1999).

The user is able to move between zones to experience different states, and using the body joystick emphasizes or amplifies the changes as well as the sense of control over those changes. The Body Joystick consists of a wireless vest, worn by the immersant, which includes sensors for both body orientation and chest expansion in breathing. It was inspired by the powerful immersive artwork Osmose of Char Davies (Davies, 1998). We have adapted the navigation idea by making the vest lightweight and wireless, and we do not use a Head Mounted Display but rather a large back projection screen (see Figure 3).

**Figure 3**, The Body Joystick in use.

The Exploratorium thus consists of three "zones" arranged vertically, very loosely based on Danté's Comedy: Purgatorio (central zone, Figure 4), Paradiso (top zone, Figure 5) and Inferno (lower zone, Figure 6).



**Figure 4**, An image of the Purgatorio zone

The city, beach and sea do not actually completely encircle the Park. Rather, it is implemented as a segment beyond which the user cannot stray. Buildings, rocks, and other features will provide barriers to make this seem natural. The sea extends out to a horizon where it meets the sky in the distance. No sun can be seen, but this level is well lit.

Paradiso is designed so that the user will have an experience that reflects a relaxed, even transcendent state of mind – where things happen as if internally. Paradiso is located above

the clouds, so the sun always shines when it is up. The sun remains fixed in one place. The view from Paradiso shows infinite sky above (and to the sides) and cloud layer below. As the visitor moves around Paradiso, she hears various Heavenly sounds in different places. The sounds will also be modulated according to how high the visitor flies. In the sky there are mandalas and castles in the background.



**Figure 5**, Image from Paradiso

The visitor can sink down into the cloud, but only to neck level, i.e. the lowest viewpoint is the level of the top of the clouds. Collision detection prevents the visitor from going down through the clouds. If the user navigates into some specific areas she "falls" down to inferno (the hellish zone).

The Inferno is large and complex enough to evoke feelings of getting lost and/trapped, of a bounded maze-like set of interlinked places, with no obvious way out. Outside the maze is a dead, dark garden. The entrance of the maze area provides access to "The Gates of Hell". The entrance is dark and wooded, with tense expectant music. Inside the Inferno, the visitor must navigate around this maze to get anywhere.

This is an unpleasant place, with discordant sounds which we are designing, sudden loud noises in unpredictable places, perhaps screams, noises of machinery, low frequencies, and explosions. Fog pervades the whole zone, with both distance and particle-based elements. Ghosts, and other unpleasant-looking things, sometimes emerge out of the fog. The centre of the Inferno is a lively, large and noisy fire. Here there are also some of the most off-putting noises: screams, things smashing and breaking. It is unpleasant to be close to the fire. There

are a few places that can take the visitor out of inferno. Depending on the place the visitor is transferred to Purgatorio or to Paradiso.



**Figure 6**, Two images from the Inferno zone

**The Pilot test**

The pilot test consisted of four participants, one woman and three men, with ages ranging from 24 to 51. The virtual environment, the Exploratorium, was presented to the participants on a 120" back projected screen with a resolution of 1024*768 pixels. The participants used a wireless hand held joystick for vertical navigation in the VE and wore a vest (the Body Joystick) measuring chest expansion, for vertical navigation.

Emotional aspects of the VE were measured on verbal and pictorial rating scales. Mood was measured using self-assessment on the graphical Self-Assessment Manikin (SAM) (Lang, 1985) on the two dimensions valence and arousal. Generation of specific emotions was measured using a verbal self-rating scale comprised of statements such as "I felt calm" where the respondent marks his/her answer with an X on a line ranging from 0 (not the least bit of the emotion) to 100 (the most of the emotion ever experienced). The verbal self-rating scale covered 27 statements containing emotion adjectives, where 8 were related to light mood (HVLA), 6 to neutral mood, and 13 to dark mood (LVHA) according to their pleasure and arousal properties (Morris, 1995). See table 1 below.

| Light mood (HVLA) | Neutral mood | Dark mood (LVHA) |
|---|---|---|
| Free | Attentive and alert | Enclosed |
| Happy | Bored | Sad |
| Ease-of-mind | Empty | Uneasy |
| Relaxed | Curious | Stressed |
| Carefree | Awake and spirited | Worried |
| Calm | Detached | Nervous |
| Safe/secure | | Unsafe/unsecure |
| Content/satisfied | | Frustrated |
| | | Lost/Confused |
| | | Angry |
| | | Ridiculous |
| | | Scared |
| | | Lonely |

**Table 1**, Emotions included in questionnaire divided into the three different mood states based on valence and arousal properties.

Participants were first informed of how the test was going to be carried out, and given an introduction to the Exploratorium and the navigation tools. Each participant was presented to each of the three different zones from the Exploratorium, one at a time, during 5 minutes, while their behavioral reactions were captured on video. During their presentations they were not able to navigate to another zone in the Exploratorium. After each zone the participant was asked to rate their overall emotional experience with the graphical Self-Assessment Manikin (Lang, 1985) scales, on the dimensions valence and arousal. After this the participants rated the level they experienced of 27 emotion adjectives. Concluding interviews were held with the participants after completing all three zones in order to determine their experience of using breathing for vertical navigation, their overall understanding of the questionnaires and if they wanted to add anything not yet covered.

Since the experiment was conducted recently, the analysis of all data has not yet been completed. Behavioral measures consisting of video recordings of the participants are therefore not analyzed in this paper. Due to the low number of participants no extensive statistic analysis can be done in this pilot test, therefore the analysis is limited to studying means in order to investigate possible tendencies to differences in emotional impact between the zones in the Exploratorium.

**Valence and arousal**

Participants experienced highest valence in Paradiso, somewhat lower in Purgatorio and lowest in Inferno. For arousal the results where opposite, e.g. participants reported the highest arousal in Inferno, followed by Purgatorio and lowest arousal in Paradiso. For mean values see Figure 7.
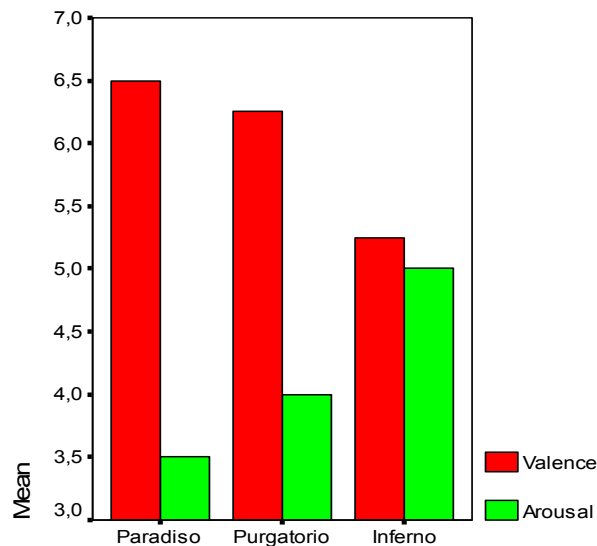


**Figure 7**, Mean values for valence and arousal for each of the three zones in The Exploratorium (min=1, max= 9)

**Specific emotions**

Summaries of emotions related to light mood (HVLA), dark mood (LVHA) and neutral mood show differences between the zones (figure 8). Participants reported highest levels of light mood related emotions in Paradiso (56.8), lower in Purgatorio (56.4) and lowest in Inferno (36.9). Neutral mood generated highest levels in Paradiso (45.9), lower in Purgatorio (44.1) and the lowest levels in Inferno (41.6). Participants reported highest levels of emotions related to dark mood in Inferno (40.5), lower in Purgatorio (23.0) and lowest in Paradiso (21.0).
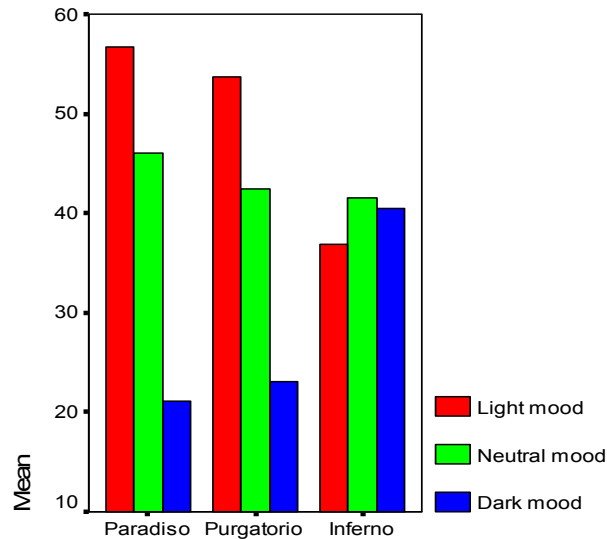
**Figure 8**. Mean values for summaries of emotions divided into Light mood, neutral mood and dark mood, for each of the zones in The Exploratorium (min=0, max=100).

The difference between the participants ratings of light mood related and dark mood related emotions where calculated for each zone (light mood – dark mood). These results show the highest values for Paradiso (35.7), lower for Purgatorio (30.6) and lowest for Inferno (-3.6). See figure 9.
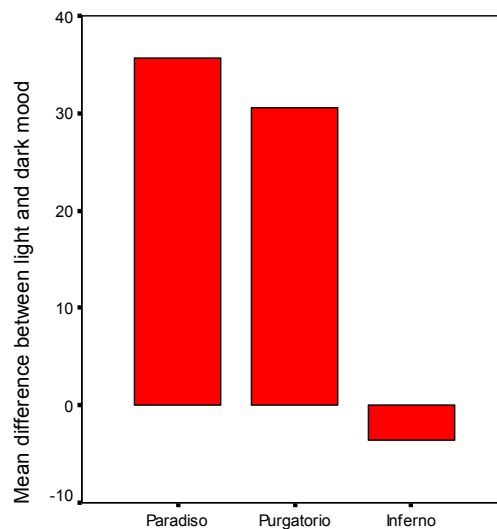


**Figure 9**, Mean values for calculated difference between light mood and dark mood related emotions for each of the zones in The Exploratorium.

The most considerable differences between the zones for specific emotions where reported for the statements "I felt stressed", "I felt ease-of-mind" and "I felt enclosed". Considerable differences in means where also shown for the statements "I felt content", "I felt bored", "I felt awake and alert" and "I felt calm". For mean values see table 2.

| Emotion | Paradiso | Purgatorio | Inferno |
|---|---|---|---|
| 1. Free | 52,3 | 39,8 | 41,5 |
| 2. Stressed | 12,8 | 29,7 | 56,1 |
| 3. Attentive and alert | 35,3 | 48,7 | 47,5 |
| 4. Empty | 38,0 | 24,6 | 39,8 |
| 5. Ease-of-mind | 59,5 | 67,6 | 37,5 |
| 6. Worried | 19,3 | 27,5 | 34,6 |
| 7. Sad | 17,5 | 16,5 | 28,6 |
| 8. Happy | 47,2 | 58,3 | 36,2 |
| 9. Confined | 16,9 | 61,0 | 64,6 |
| 10. Content | 51,3 | 62,9 | 30,3 |
| 11. Bored | 55,7 | 33,9 | 32,6 |
| 12. Safe | 60,4 | 61,9 | 43,1 |
| 13. Scared | 10,8 | 6,36 | 34,2 |
| 14. Uneasy | 10,6 | 20,3 | 41,3 |
| 15. Relaxed | 63,0 | 59,5 | 31,6 |
| 16. Angry | 7,8 | 5,3 | 16,3 |
| 17. Carefree | 50,4 | 46,1 | 33,9 |
| 18. Lost/confused | 39,2 | 20,3 | 53,7 |
| 19. Frustrated | 45,1 | 46,2 | 58,6 |
| 20. Awake and spirited | 46,3 | 63,1 | 42,8 |
| 21. Lonely | 43,0 | 28,2 | 41,0 |
| 22. Detached | 32,3 | 18,6 | 24,4 |
| 23. Unsafe | 17,6 | 15,0 | 36,0 |
| 24. Calm | 69,9 | 54,9 | 41,3 |
| 25. Curious | 68,2 | 75,6 | 62,5 |
| 26. Nervous | 14,4 | 8,7 | 35,8 |
| 27. Ridiculous | 18,4 | 15,5 | 25,4 |

**Table 2**, Means for specific emotions in each zone in the Exploratorium (min=0, max= 100)

**Use of the Body Joystick**

Use of the Body Joystick for vertical navigation is possible in certain areas in the Exploratorium, and mainly in Paradiso and Inferno. Observations of the participants during

the presentations showed that all participants used the feature, but only in Paradiso. In the concluding interviews after presentations participants reported both positive and negative aspects of the use of the Body Joystick. The negative aspects included experienced lack of feedback where participants wanted more vertical transportation as an effect of their breathing, and also that they had to remind themselves in order to use their breathing for vertical navigation. On the positive side participants found the concept of using breath for vertical movement appealing, easy to learn, and they described their experience as "flying".

**Conclusions**

The results from valence and arousal measures are in accordance with the intended mood-generation properties of the different zones, where results from Paradiso showed high valence and low arousal, Inferno the opposite and Purgatorio scored in-between these two extremes. These results indicate that the different zones in the Exploratorium are able to enhance or even generate the three mood states light mood (HVLA), neutral mood and dark mood (LVHA).

Regarding emotions, the results show that participants experience higher levels of emotions related to light mood (HVLA) in Paradiso, and lower in Inferno and the opposite for emotions related to dark mood (HVLA). These results are in accordance with the valence and arousal ratings for these zones and give support for the intended mood generating properties of these zones. Regarding emotions related to neutral mood the results are a bit more complex. One might have expected highest ratings of neutral mood related emotions in Purgatorio, since it is intended to be the most neutral zone, but that was not the case here since Paradiso received higher ratings. One explanation can be that what constitutes a neutral mood is not just the kind of emotions experienced, but also the level of the emotions in such a way that there is a balance between emotions

The calculated difference between the ratings of light mood related and dark mood related emotions can be seen as a measure of the total mood state generated in each zone. These results show highest scores for Paradiso, lower for Purgatorio and lowest for Inferno, which give support for the mood generating properties of the zones intended in the design of the Exploratorium.

As the results show, the participants in this study only used the breathing feature of the Body Joystick in one zone, namely Paradiso. One explanation for this is that this feature is activated all over this zone, but only in a few small areas in the other zones. Participants may have tried to use this feature a few times in all zones but only found it working in Paradiso and therefore gave up trying in the other zones. Another explanation is also that the participants spent too short time in Purgatorio and Inferno in order to find the areas where they could use their breathing for navigation. This is something that most likely will not be a problem when using the Exploratorium as a whole, since users then can spend a lot longer time exploring in each zone. The experienced lack of feedback when using the breathing-feature of the Body Joystick can be explained by imperfect calibration of the device, due to shortcomings in the vest design. The Body Joystick vest will therefore be redesigned for future testing. The issue of participants reporting having to remind themselves of using the breathing feature of the Body Joystick is important. One possible explanation can be that the user receives to little cues as to when the feature is activated, which must be studied further. Overall, the participants reported a positive attitude towards the concept of vertical navigation through breathing, which also seems to be easy to use. The results confirm that the Body Joystick is simple and intuitive to use and that using breath control maps naturally onto vertical navigation, as in diving and snorkeling. The reported feeling of "flying" in Paradiso is also a positive result since it can increase the experienced valence and add emotions such as "freedom" to the light-mood-generation intended in this zone.

The results from this first pilot study cannot be seen as statistically significant but show tendencies which indicate that the Exploratorium does indeed function as a mood generator, and that the different zones generate the intended mood states. We are encouraged to continue this line of research into the relationship between the design of interactive environments and the emotional states of those who experience them.

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