

The Illusion of Non-Linearity in Open World Video Games

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ABSTRACT

Autonomy is an important aspect of game design that drives player motivation and enjoyment, though it can be difficult for designers to provide freedom and autonomy while keeping well-structured levels. This paper explores a concept that might help in doing so: the illusion of non-linearity. Players receive the choice to go to several levels in an open world, but the first they go to is always the first level in a linear set of levels, the second level they go to the second and so on, causing players to think they have freedom of choice, giving a sense of autonomy, while giving the game's designers the power to create well-structured levels. The concept was implemented in a short game and tested against a completely linear version of the same game. Though no significant differences were found, the concept might prove a valuable tool in game design if explored further.

Author Keywords

Self-Determination Theory; Cognitive Evaluation Theory; Autonomy; Video Games; Open World Games; Linearity

INTRODUCTION

Self-determination theory and cognitive evaluation theory teach us that to make an activity more intrinsically motivating one has to assure it provides a feeling of autonomy, competence and relatedness [14]. This also holds true for video games, where it has been shown that providing these feelings increase enjoyment and willingness for future play [15].

Another theory used for increasing engagement in games is that of Flow [2]. If a game balances out difficulty and challenge, it will keep players in a state of flow that is very engaging [18]. Games with a lot of choices can let players make choices that keep them within their own flow state. Experienced players can choose to take a more challenging approach while a novice player might avoid some challenges [1]. Thus, a sense of autonomy is also important in eliciting the flow state [2].

Needless to say autonomy is very important. People feel more autonomous when something they do is done with volition and personal agency [8,10]. Game designers have several ways to give players a strong sense of autonomy within their games. Open world games in particular present players with vast worlds full of freedom and choices that the player can engage with [17]. These games often feature multiple ways to reach an end goal, different missions to choose from, what skills they acquire and even their character's appearance, all supporting the sense of autonomy[8].

Open world games have become incredibly popular over the last decade, becoming one of the biggest genres of games[10]. However, this emphasis on player autonomy can sometimes be at odds with game designers' focus on creating coherent stories and well-paced gameplay [9,6]. This is why many open world games still feature a linear narrative that guides players through the world. In Rockstar Games' Red dead Redemption 2 [11], players are presented with a vast, open world to explore, but the story takes them from location to location in a set order.

Increasing the number of choices in a game can be costly and time consuming for the developers [1], which is why designers often try to direct players into making a certain decision, while still giving them the illusion they had more than one choice. The book "Level Design: Processes and Experiences" [18] features an entire chapter on how to hide linearity from players, for example by giving the player two paths, but blocking one with a group of strong enemies. The player is likely to pick the open path, and feels as if this was their own choice. This creates an illusion of autonomy for the player, while giving designers more control over the flow of a level.

The risk of using these methods is that there is a possibility the player will notice they are being forced to make a certain decision. If this decision is still in accord with the player's goals and they willingly make the choice, it can still feel autonomous[19]. However if the decision the player is being forced to make goes against the will of the player it will have the opposite effect of what the illusion of autonomy is trying to accomplish. The player's sense of autonomy fades and their motivation does too [15].

Some open world games give players more freedom in how they approach the world and its contents. Providing a less linear experience and options for true autonomy and open ended play. The Legend of Zelda: Breath of the Wild[7] gives players much more autonomy, allowing them to go anywhere at any point, but at the cost of a coherent narrative. Breath of the wild's narrative is near-absent, only consisting of a small number of cutscenes featuring flashbacks to a time before the game's events even began.

Breath of the Wild features 120 small challenges inside of "shrines" spread across the world, each of which can be found and accessed at any point in the game past the tutorial. The non-linearity makes it so that each shrine has to stand by itself, as there is no way of knowing in what order the player will encounter them. This makes the levels harder to design,

as designers can't build on concepts introduced in other levels. They either have to be introduced before the world opens up, as the game does in its tutorial area, or within each of the levels.

Another risk of the non-linearity is that players might encounter a challenge that is too difficult for their current level or skill. In *Breath of the Wild* for example, it's possible for the player to encounter a difficult combat challenge shrine before encountering the combat tutorial one.

One way game designers deal with these problems is through Dynamic Difficulty Adjustment (DDA)[5,20]. DDA automatically changes the difficulty of a game based on player performance and level, making it so that the player is always kept in a flow channel. This is mostly done by increasing or decreasing enemy difficulty.

While DDA can solve the difficulty of enemy difficulty not matching player levels, it is much harder to apply it to level difficulty and nonlinear levels on the scale of an entire open world, like we see in *Breath of the Wild*. In cases like these it might be better to present these challenges to the player in a linear fashion, whilst still giving them the feeling of non-linear exploration that the open world provides. An illusion of non-linearity.

Using the previous example of combat challenges in *Breath of the Wild*, the game could keep the overworld the same, but present the combat challenges linearly. The first combat challenge the player encounters would be the tutorial, and from there on every new encounter would increase in difficulty. Hypothetically, such an approach can take the benefits of linearly designed levels and combine them with open world freedom. This poses an interesting research question: Does the illusion of non-linearity increase engagement in video games?

It was expected that the inclusion of this illusion in an otherwise linear game would increase the perceived feeling of autonomy and level of enjoyment, while the perceived feeling of competence should stay mostly the same.

DESIGN

To help answer this research question, a game was created using Unreal Engine 4 [4].

Game versions

Two versions of the same game were created, so that the difference between the two could be measured. The game was similar to a "the Legend of Zelda" game, in which the player has to fight enemies and solve puzzles in a number of levels, accessed through an open world (figure 1). In this case, the levels were accessed through Fortresses placed in the world.

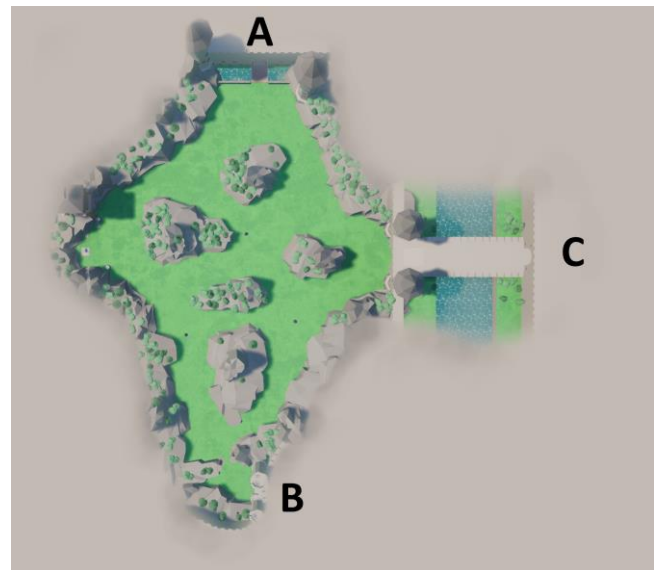


Figure 1. The overworld of the game, featuring the three fortresses (A, B and C).

One version of the game was sequential, it forced the player to access the fortresses in an order: A, B then C. Forts B and C were made inaccessible from the start (figure 2). At the end of a level, the player would collect a key that they could use to access the next fort. This resulted in an experience that was noticeably linear to the player.



Figure 2. The gate to fort B being locked.

The other version featured the illusion of non-linearity. In this version, none of the forts were made inaccessible. The player could enter any of the forts from the start, but the first one they entered would always contain the first level of the sequential order, the second level would be the second and so on. As an example, the player might enter fort B first, which in the sequential version would be the second level, but since it is accessed first, it will load the first level.

A third version, in which the levels would have been truly non-linear (fort B always loads level 2), was considered and made but was not used in this research as there weren't enough participants to gather data on it.

Gameplay

The game itself had a simple style, with a top down camera perspective to make it intuitive and accessible for a large number of players. Players could use the WASD keys to move the characters around and use the mouse to look around, use items and interact with objects.

The game featured 3 items the player could use: a sword, a boomerang and a boxing glove on an extendable spring called the spring glove. The sword was a basic, short range attack that could be used to fight enemies. The boomerang could be thrown and controlled using the mouse to activate switches. The spring glove was a ranged attack that could be used to deal damage and push blocks.



Figure 3: all three items in use: The sword (left), Boomerang (middle) and Spring glove (right)

Players started out in a tutorial level, which introduced the items to them one at a time. It was initially planned to have the items unlock within levels, though as this might have revealed the linear nature of the levels to players, this tutorial level was created instead.

There were a total of 3 levels, this was done to give the player enough choice while keeping the scope of the game attainable within the time frame of the project, and keep the length of the game reasonable for a participant to be willing to spend time on.

Each level contained three to four small puzzles and a couple of enemies to fight. The puzzles in the first two levels focused on a single item or mechanic, like pushing blocks or using the boomerang. The third and final level built on these mechanics and combined them (players had to push blocks and use the boomerang). The difficulty of each level also increased by featuring more enemies and a stronger enemy type which dealt more damage and had quicker attacks. Players couldn't exit a level once they entered, as this could either break the linearity of the game (players skip levels), or the illusion of non-linearity (players notice every level they enter is the same).

METHODS

The designed game could be used to measure the effect of the illusion of non-linearity by measuring participant's perceived levels of autonomy, competence and enjoyment. These measurements could then be compared between the two versions of the game. Since playing both versions of the game would make it very obvious to players that the levels are linear in both versions, shattering the illusion of non-linearity, this research made use of between subjects testing. The game randomly assigned a player to one of the two conditions. There were a total of 30 participants, spread equally among the two conditions.

Participants were recruited through relevant social media channels (such as video game forums on Reddit and Discord) and through word of mouth. This was done to assure participants were at least interested in or had experience with playing videogames. They were asked to play the full game and complete a survey afterwards, totaling around 20 minutes. The game could be downloaded via a Google Drive link and played on their own computer at home. Participants were not told about the purpose of the study beforehand, only that it was "researching game design".

Once completed, the game gave the participant a link to an online form that asked them to reflect on their play experiences. The forms consisted of 13 items, each a seven-point Likert scale item (1 = Do Not Agree, 7 = Strongly Agree), presented in a random order. There were 3 statements measuring the perceived feeling of competence (e.g., "My ability to play the game is well matched with the game's challenges"), 3 statements measuring the perceived feeling of autonomy (e.g., "The game provides me with interesting options and choices"), and 7 statements measuring the participant's enjoyment (e.g., "I enjoyed playing this game very much.").

The items measuring competence and autonomy were taken from the Player Experience of Need Satisfaction Questionnaire (PENS scale) [3,13,12], a scale used to assess gameplay experiences, based on self-determination theory. The items measuring the level of enjoyment were taken from the Intrinsic Motivation Inventory (IMI) [16], a scale used to assess participant's experiences to activities in laboratory settings.

RESULTS

The survey results were analyzed using an independent-sample t-test to determine whether there was any significant difference between the two game versions.

Competence

The experienced feeling of competence was expected to stay the same between the two versions of the game, which it did. The sequential version received a mean score of 4.978 (SD = 0.955), the same score as the version of the game with the illusion of non-linearity (SD = 0.971).

Autonomy

The feeling of autonomy was hypothesized to be higher in the version of the game with the illusion of non-linearity, however no significant change was found (4.311 vs. 4.175, $t(28) = 0.257$, $p = 0.799$).

Enjoyment

The level of enjoyment was expected to either be the same across both versions, or higher in the version that included the illusion of non-linearity, though again no statistically significant difference was found (5.286 vs. 4.752, $t(28) = 0.961$, $p = 0.345$).

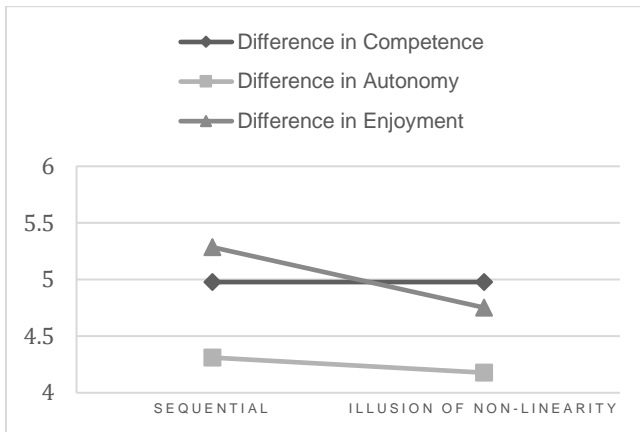


Figure 4: Differences in the means of the feelings of competence, autonomy and enjoyment.

Although there was no significant difference between the two versions of the game, autonomy and enjoyment were found to be strongly correlated ($r(28) = 0.69$, $p = <0.001$). This correlation could be found in both of the test groups, as can be seen in table 1.

Test Group	$r(14)$	p
Sequential	0.75	0.001
Illusion of non-linearity	0.65	0.009

Table 1. Correlation between autonomy and enjoyment across the two test groups.

There was also a correlation between competence and enjoyment ($r(28) = 0.364$, $p = <0.048$).

DISCUSSION

The results seem to indicate that the inclusion of the illusion of non-linearity does not improve the overall game experience, nor does it significantly detract from it.

The correlations between autonomy and enjoyment, and between competence and enjoyment are in line with what one might expect based on cognitive evaluation theory [14]. This could be seen as an indication that the data is valid, and participants answered truthfully. There are however a number of other reasons that might explain the results, or lack thereof.

There are many factors in a game affecting the feeling of autonomy, way more than just choices in an open world [8,10]. The illusion of autonomy might affect certain aspects of autonomy while not affecting others, thus only having a small effect on autonomy as a whole. Since the PENS scale only measures autonomy as a whole, having more questions on different aspects that influence autonomy could have painted a clearer picture of the full effect

Additionally, when looking at autonomy through the lens of volition and personal agency, it could be argued that the game in its current state does not necessarily provide either. The game did not have a clear goal beyond simply completing the game, so players had no short terms goals or

reasons for wanting to complete a fort. The sequential version of the game had a little bit of this, as players collected keys at the end of forts, which might be seen as more rewarding.

It is also possible that players playing the version of the game with the illusion on non-linearity noticed their choices didn't matter, causing them to feel less autonomous [15]. It is worth mentioning that this is something that might happen when a person plays the game multiple times. Although this is not something that happened in the research (participants filled in the survey after beating the game only once), it would occur if the illusion of non-linearity were to be implemented in a mainstream game. Players might notice in new playthroughs, that their choices don't matter, and the illusion will shatter.

Within the research, inconsistencies in the overworld design could have also taken a part in lessening the effect of the illusion. Players might have expected a more difficult level when entering the fort that is across a wide river, but might have been presented with an easy level instead.

Both versions of the game were ecologically valid, meaning they both looked and played like a regular game one might see published. This made the difference between the two versions quite small, potentially being one of the causes of the small difference in results. Had there been a bigger, more exaggerated difference between versions, clearer results may have come forward.

On top of that, game was also quite short, which was done to make the study not last too long. This is unlike most open world games, which can take many hours to complete. Perhaps players don't feel as much a need for autonomy in shorter play sessions as they would with large open world games.

The way participants were gathered could also have played a role. By gathering participants through social media, there might have been a large variety in participants. Some of them might have preferred more linear, structured games over open ones.

Future work

Although this study did not yield any major findings, there is certainly potential in the concept of the illusion of non-linearity that could be looked into in the future.

Repeating the study, fixing its shortcomings in game design (like the levels not being inherently rewarding in and of themselves), increasing the number of participants and gathering deeper insights into different aspects of autonomy might already give new insights on the topic.

New methods to strengthen the effect of the illusion could also be studied. For example, changing the aesthetic of the levels to amplify the illusion (entering a fort in a volcano will theme the level with red bricks, and lava instead of water).

It also has to be explored what the best way to implement the illusion of non-linearity is. Trying to apply it to major elements of a game, such as the main levels of a Zelda game might not work due to the structural and thematical importance these levels have, but it might be a valuable addition to side activities like the shrines in Breath of the Wild.

CONCLUSION

This study set to find out whether the illusion of non-linearity could be a meaningful tool in providing autonomy as well as well structured levels in an open world game setting. While no significant results came out of this study, the concept of the illusion of non-linearity might become a useful tool in open world game design if explored further. More research is necessary to determine the exact effect of the illusion has on certain aspects of autonomy, and what role it can play in games exactly.

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APPENDIX A

Reflection

This project was the first time for a lot of things. It was the first time in my study as a designer where I had to conduct a research on my own, where in previous projects I always worked in a team. I often let team members take care of aspects of the research such as literature studies and user testing, mostly because I didn't always find them particularly interesting and rather worked on the prototype instead. This has caused me to not develop much in these areas. In my M1.1 design project it became very apparent I was lacking skill in them. So this semester I set out the goal to focus on these areas to the best of my ability. Both in this project, and in the course "Constructive Design Research" I tried my best to gather knowledge on the subjects I was working with and go much more in depth into the literature I otherwise would have. The first few weeks of my project were spent looking for literature, trying to find many sources, checking the references of studies I found useful for more sources and already writing about my findings in a literature study I could use for my final paper. The latter was something I would normally leave for the end of a project, which usually ended up showing in the final result. Personally, I am very satisfied with my progress in the area of dealing with scientific information and I will certainly approach a new project in a similar way.

The user study performed in this research was one of the most extensive ones I have done in all my time at ID, which was necessary to get meaningful results out of the study. I made my game available to download online so I could use social media to gather participants. The number of participants gathered online fell a bit short of my expectations however, and I still had to ask around quite a bit to get the number of participants I did. I expect having to download the game was quite a big barrier for people, especially since it regarded a .exe file which could easily be seen as a virus. A better approach would have been to make the game playable in people's internet browser, but this was sadly not supported by the version of unreal I developed my game in. For future studies, I will use a game engine that supports browsers to facilitate testing.

Another first for me this project was the fact that I made an entertainment game instead of a serious game, which so far all the games I have made during my study have been. It was also the most complete game I have ever made and the first time I have made a game played on a computer rather than on a phone or in virtual reality. There were a lot of different design considerations I had to make because of all this. Instead of starting with the question "how can I teach x in a fun and engaging way", I simply asked myself "how can I make a fun an engaging game". I knew that I wanted to make a Zelda-type game to implement the illusion of linearity into pretty early on in the process, so it quickly became a case of coming up with fun items to make interesting puzzles out of. An important aspect to these items was that they needed the potential to be built upon, so that I could make levels where the concepts were explored further and further. Once I had my main mechanics finished I could start designing the levels and puzzles of the game. Getting all the mechanics to work right took longer than expected however, so I did not have much time to iterate on the design of the game. Only minor changes, based on user testing with friends, were made. I did try to flesh out the design to the best of my ability, and there are some parts I am quite proud of. For example, when teaching the players about pullable blocks, a block is placed against a wall, where the only option is to pull it onto a switch (as can be seen on the right).



One of the reasons the making of the main mechanics took so long was because at times I would become too perfectionistic in trying to polish up a game mechanic. Although I did have a list of all the mechanics and features I wanted in the game, I didn't define exactly what they should be like. While programming I would get carried away pretty easily. When time was becoming an issue, I started to make clear lists of what the exact things were that I needed to program to be able to make the final game. From this point on, I worked much more efficiently. In future projects I should make clearer lists like these to help me stay focused.

The final first of this project for me was doing a statistical analysis in SPSS. During the course "Constructive Design Research" I conducted a small statistical analysis using excel, just so I had an idea of what my team members had done. This project I gave SPSS a try, and though it took me some time to find my way around the program, I do feel like it ended up saving me some time with the analysis. I learnt how to conduct and interpret a t-test as well as a Pearson Correlation analysis. I plan to learn more about the possibilities of SPSS so I can use it in future projects even more efficiently.

Despite the study not yielding many findings, I am very happy with my personal progress within this project. It was a big challenge for me, tackling several of my biggest shortcomings in one project, but I feel it ended up going really well and I believe I can keep it up in future projects to come.