

The Cause and Prevention of Spatial Disorientation In Game Play

by

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3D games are immersive

- 3d games engage your senses and place you inside the game scene – as you move, your view of the scene moves with you.
- If you look up and down, the scene pitches up or down. If you look left or right, the scene pans to the left or right.
- In a darkened room with a wide screen the effect is even greater. Add sound effects and everything is there but motion.

- If you are immersed in a 3d game with all the senses engaged except for motion, your mind will try to add motion.
- The conflicting data of seeing and hearing motion when your body isn't feeling it, is what causes spatial disorientation and discomfort.
- In Motion Sickness you really are being tossed about in unexpected ways.
- The motion during game play is imagined, although it feels the same and can lead to the same result – spatial disorientation with dizziness and nausea.

The format of our talk

- During the remainder of the talk we will alternate between discussion and examples.
- This will, hopefully, avoid any undue discomfort. I am probably more susceptible than most of you and I'm doing this for myself also.
- If you do feel uncomfortable, just look away from the screen until the disorientation passes. This can take several minutes – we will try to give you a break.

Halo (PC version)

- “Halo I” was a very popular video game, primarily of a first-person-shooter type (although a race game mode is available).
- The race game has, in my opinion, one of the best driver control systems ever seen.
- Special care was taken in the camera placement (position and pointing) for the driver, right-side passenger and the rear-gunner.
- Spatial discomfort is greatly affected by camera placement.

Driver's view (High looking from behind jeep)



Driver's view

(High looking from behind Jeep)

- The rear camera looking down towards the front is much like looking out towards the horizon while seeing enough to control the Jeep.
- You “almost” perceive yourself as an observer, not someone to whom the action is happening.
- This distancing yourself from the local up-and-down, side-to-side motion you'd see at eye level greatly alleviates spatial discomfort.

Driver view (video clip – high up)



Driver's view (after clip discussion)

- Even though we were making turns and rather fast side-to-side movements, the spatial discomfort was manageable.
- This is a little hard to demonstrate because of another issue. It is harder to watch a fast action video game being played than it is to play a fast action video game.
- Why is this? For the same reason it is more comfortable to drive a curvy road than it is to be a passenger. As the driver, you have a better idea of what is going to happen next – you have less unexpected motion.

Driver's view (after clip discussion)

- This goes further – it is better to be the front seat passenger in a car than a passenger in the back seat.
- This is because of two things: (1) less unexpected motion and (2) a better forward view with less perceived motion from the side of the car.
- O.K., we are going to try it again with the camera view, lower down, more what the driver would actually see.

Driver's view (camera low down)



Driver's view – low down (after clip discussion)

- O.K., that was worse. Still the spatial discomfort wasn't too bad because we were looking outward at a mostly open vista – we could often see the horizon.
- A more cluttered view would increase the side-to-side motion and increase our spatial discomfort.
- O.K., in this next clip we are going to get a view from the Jeep's rear runner.

Gunner's view (Looking at target high up on Jeep)



Gunner's view

(high up on Jeep discussion)

- The gunner is high up on the Jeep looking out towards his target. He is focused on a distant object, off toward the horizon, and is not as affected by spatial displacement as the front side passenger.
- The gunner's focus on his distant target greatly alleviates spatial discomfort – he is almost as comfortable as the driver.

Gunner's view (High, looking at target high up on Jeep)



Passenger's view (Low, looking at eye level)



Passenger's view

(Low, camera at eye level)

- The camera placement at eye-level for the right-side passenger was a very poor choice for this game. I have played this game many times and no one likes to ride as the right side passenger.
- The passenger has more unexpected motion and a worse forward view with more perceived motion from the side of the car.
- Normally, it should be as good as the driver, but remember the driver view is unreal – in the game it is high up and behind the Jeep.

Passenger's view

(Low, camera at eye level)

- This is why it is so important to select your camera's placement with care. You always hear about how people want more realism in game play, but this is only true to a point.
- People want only as much realism in a game as is required for them to feel immersed and engaged, but not to the point of being uncomfortable or ill. The game, after all, is supposed to be enjoyable.
- O.K., lets see the film clip from the right-side passenger. **Remember, you might want to look away after a moment of play, to avoid spatial discomfort or nausea.**

Passenger's view (Low, looking at eye level)



Passenger's view (Low, camera at eye level)

- The ride was just as bad as we thought it would be. The passenger had more unexpected motion and a worse forward view with more perceived motion from the side of the car.
- For people who are susceptible to spatial discomfort it would have quickly become very unpleasant.
- Another point about spatial discomfort is that once a person has tolerated it for a few minutes, it can take from minutes to well over an hour to feel well again. If you don't suffer from motion sickness you will never truly understand.

Driver's view (reduced realism)

- For a moment, let's return to our point about realism in games. In this next video clip, the Jeep will run up the side of a steep ridge and then off its edge without damage to itself or the passenger. Not very real but very fun...
- The view is from high and behind the vehicle, so even though the driving is chaotic there should be little spatial discomfort.

Driver's view (stunt video clip)



Ghost (side-to-side and turns)

- Halo has another vehicle called the Ghost – a kind of flying hovercraft, floating on a repulsion field. We are going to use it to demonstrate some other causes of spatial discomfort - rapid turns and side-by-side motion.
- Quick turns or whipping from side-to-side causes an increase in rate of turn or side-by-side motion. Both of these can result in some spatial discomfort.
- The view of the driver is fairly high and behind the vehicle, so there should be little spatial discomfort from camera positioning. It is all from side-to-side motion.

Ghost

(slow left-right turns)



Ghost (slow left-right turns)

- That wasn't bad at all. The view of the driver was fairly high and behind the vehicle, so there was only minor spatial discomfort from camera positioning.
- The side-to-side motion and the rate of turn was slow, so the perception of side motion was well within most people's limits.
- It was a little jerky... The slowing of our turn was done by mouse movement, where a few centimetres of movement translated to a larger shift on the screen.
- Lets see what a normal speed run might look like.

Ghost (fast left-right turns)



Ghost (after-clip discussion)

- Yes, the faster left-right turns and side-to-side movement was harder to watch and did cause more spatial discomfort.
- A solution would be a more controlled turn. It is true that slower turns will disadvantage a player. This could be fixed by having the same rate for everyone or just letting the player take the loss in turn-rate.
- This could be done in-game with a “mouse sensitivity slider”, under game options. You are really just varying the mouse sample rate. I've seen this in several games, although they often don't allow you to adjust the rate low enough to do much good.

Special (Gamer's mouse)

- OCZ Technology “equalizer” OCZMSEQRD has On-mouse 6-DPI-Shift (400-800-1200-1600-2000-2500) allowing you to change your mouse's read-sensitivity on the fly.



Head-bob with side-to-side motion

- The last cause of spatial disorientation is the side-to-side head-bobbing that is sometimes seen in 3D games.
- In real life this is caused by a person's walking or running gait. As we walk or run, our movement from our left to right foot causes our shoulders to rise and drop from left to right.
- With a smoother gait this motion is less pronounced. Games have mimicked this motion by tilting the camera left-to-right with a little bounce while sometimes adding sound.

Head-bob with side-to-side motion

- Some games like “Pain Killer” offer a slider that allow you to adjust the head-bob motion.



Head-bob 50% (Video clip)



Head-bob (after clip discussion)

- Yes, “Pain Killer” is another one of these violent games. I'm not going to ignore the issue, but we will get to it later – for now, lets study the spatial disorientation issues. The last clip was at 50% head-bob.
- Did you notice how the head-bobbing was aggravated or more distracting because of the weapon sticking up in the lower right-hand of the screen? The weapon image has two purposes: 1) to increase the “head-bob” effect and 2) to let you know what weapon you're carrying. Lets look at a clip with 100% “head-bob”...

Head-bob 100% (Video clip)



Head-bob (after clip discussion)

- It really wasn't much different, but we could have gone all the way down to 0%, turning the effect off.
- This is actually a case where the gaming industry has added something that is not real. If you are running or walking you don't experience motion sickness – your brain automatically ignores normal side-to-side motion.
- On a small screen with a close object (the gun) to cue your senses, it is much more difficult to ignore. The perceived, yet unfelt motion in the game causes spatial disorientation.

Head-bob (solution)

- The solution to Head-bob in games must, unfortunately, be handled at the game level. If you are bothered by head-bob you should turn it down or off, when an in-game control is available.
- Those writing games that use head-bob should provide a control to turn it down or off. After all, you don't want to unnecessarily limit the number of customers.

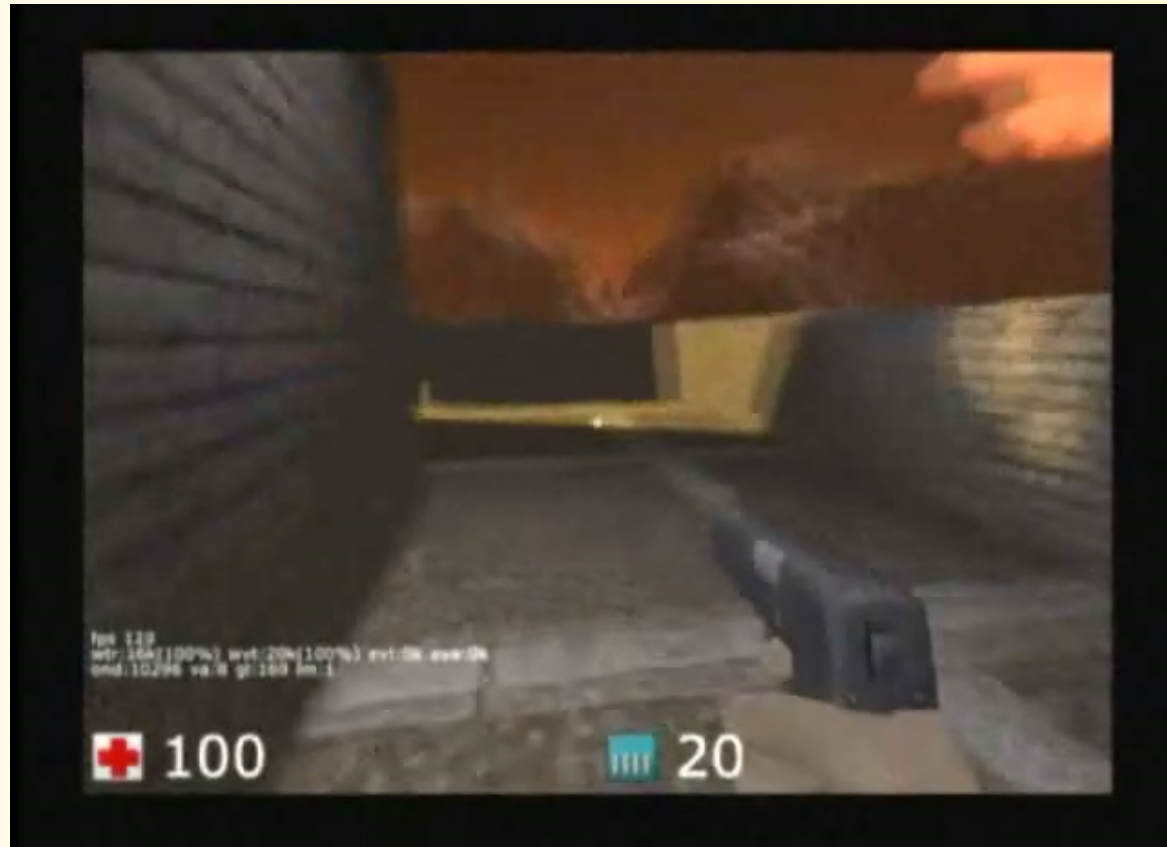
Speed and side-to-side motion

- We've already talked about side-to-side motion and turns. We know they can cause spatial discomfort.
- Speed adds to the problem, especially if you're going up-and-down terrain. It's like driving up-and-down dips in a road. For this reason, the players maximum speed and rate-of-turn should be carefully chosen. We might even add rate-of-turn to our options menu.
- Lets try both slow and fast movement through up-and-down terrain and see what happens.

Terrain movement (slow)



Terrain movement (fast)



Action games

• Action games are not puzzle games or educational tools. They offer the player struggle, fear, loss and victory. This involves a visceral response not present in typical puzzle games. It's easiest to achieve in war games, that have a kill-or-be-killed scenario.

• I prefer the racing game that gives the same thrill of play without the killing. The goal of the race is for your team to complete a certain number of laps before the other team. There is struggle with defeat or victory.

Action games

- The question is how do you get a visceral reaction during game play without killing people?
- In the racing game, it is from your team winning or your team losing – you definitely have a sense of loss or a sense of victory.
- After all, when you played sports in high-school you didn't need to kill the other team to enjoy a win over them.
- Why does anyone have to win or lose? Now we could have a debate; for me, if I can't win or lose, the game's not worth playing. I might play once but not twice. Still, I don't need to kill people.

No One Lives Forever II

- O.K., I have taught games programming for about 7 years and I don't have the answer. I am still looking for that perfect solution to the question.
- One game that I like is “No One Lives Forever II” - well not all of it but certain features. I like that it's first goal is that you sneak into town to photograph a meeting. There are puzzles to be solved but not too many. You can use a stun gun or knock-out gas, instead of a lethal weapon to achieve your goals. It also has lots of humorous dialogue.
- It's not perfect but I have learned a lot from the game.

N.O.L.F. 2 (stun-gun video clip)



Thank you

- I had fun putting together this talk. Can I answer any questions?
- Or does anyone have any comments – really, I'd like to know your thoughts.
- All the source code, slides and implementation instructions are available at:
- <http://tinyrealm.com/~efa/papers/>
- or
- <http://ed-karen.com/~efa/papers/>