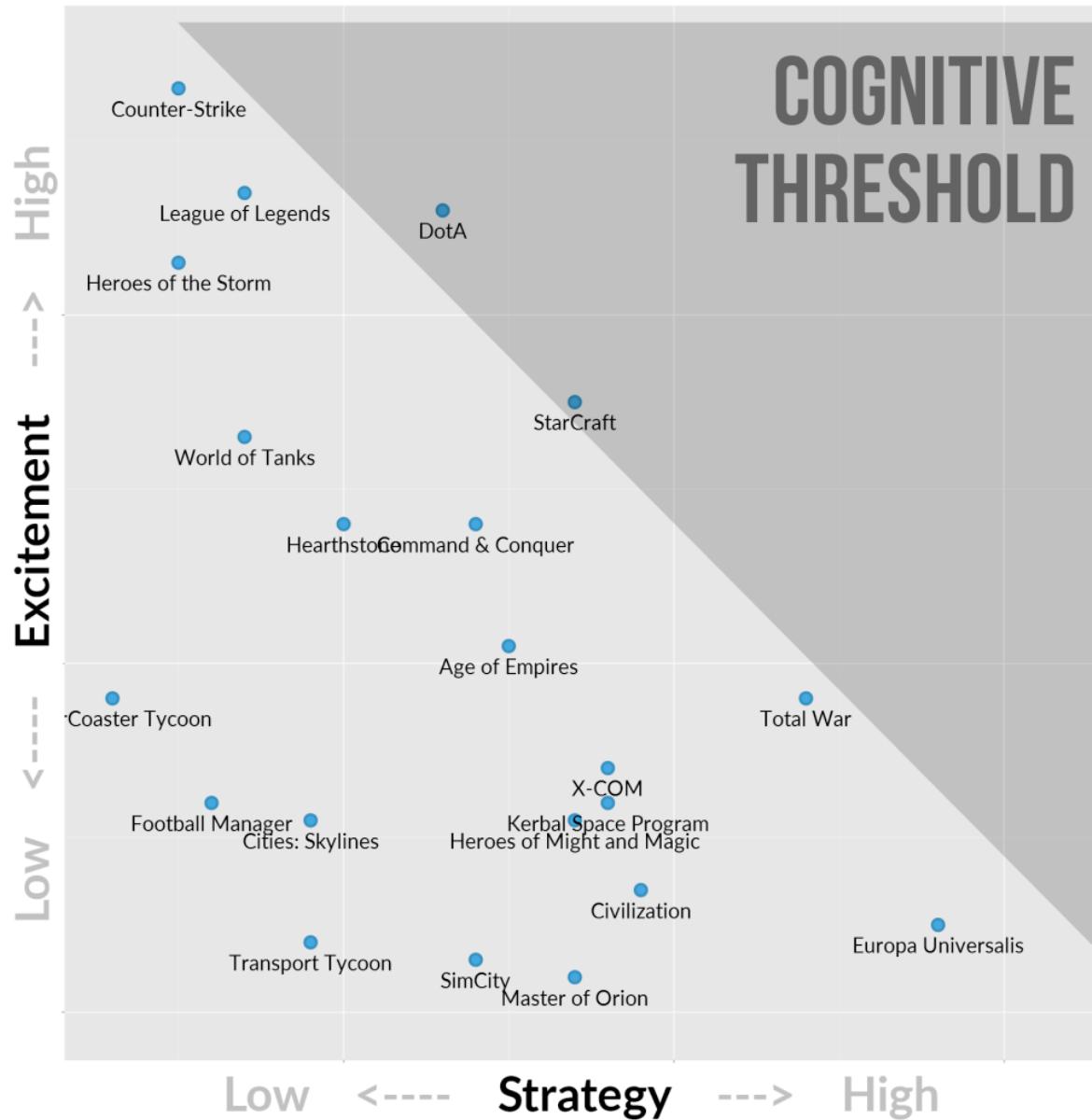


# COMP4002/G54GAM Games

Progression and Balance

# Where are we?

- Formal elements
  - Core game mechanic
  - Game play
  - **How** we play
- Dramatic elements
  - Challenges
  - **Why** it is interesting to play
- What was a game that you felt was *boring*?
- What was a game that you felt was *unfair*?



<http://quanticfoundry.com/2016/01/20/game-genre-map-the-cognitive-threshold-in-strategy-games/>

# Level Design

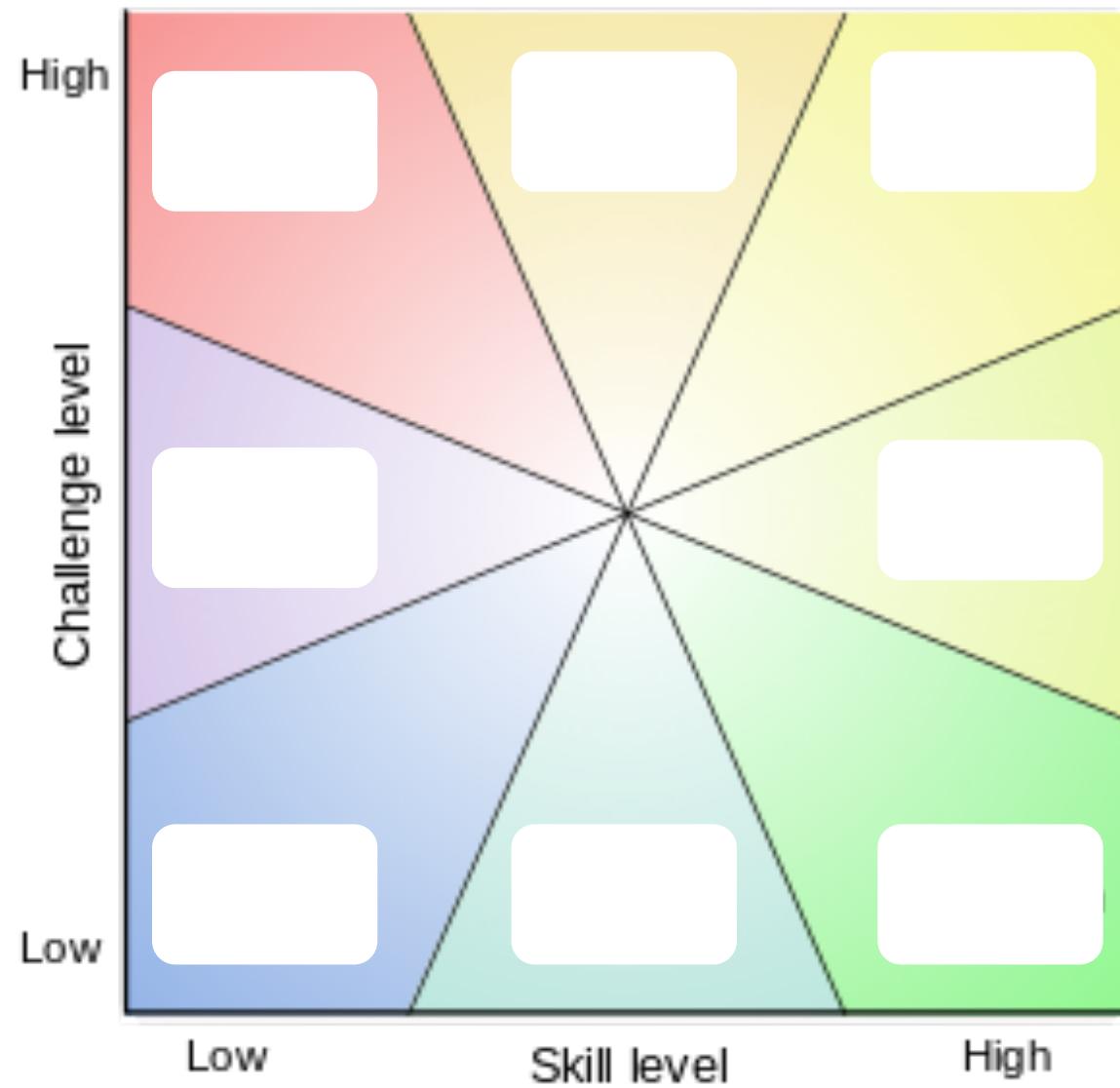
- The space in which the game takes place
  - Creating the space
- Initial conditions
  - Number of opponents, amount and location of resources
- **The set of challenges the player will face**
  - Often a linear sequence of levels, linear or non-linear sequence within a level
- The termination conditions
  - Winning or losing
    - Some levels can only be “lost”
- Interplay between gameplay and story
- Aesthetics and mood

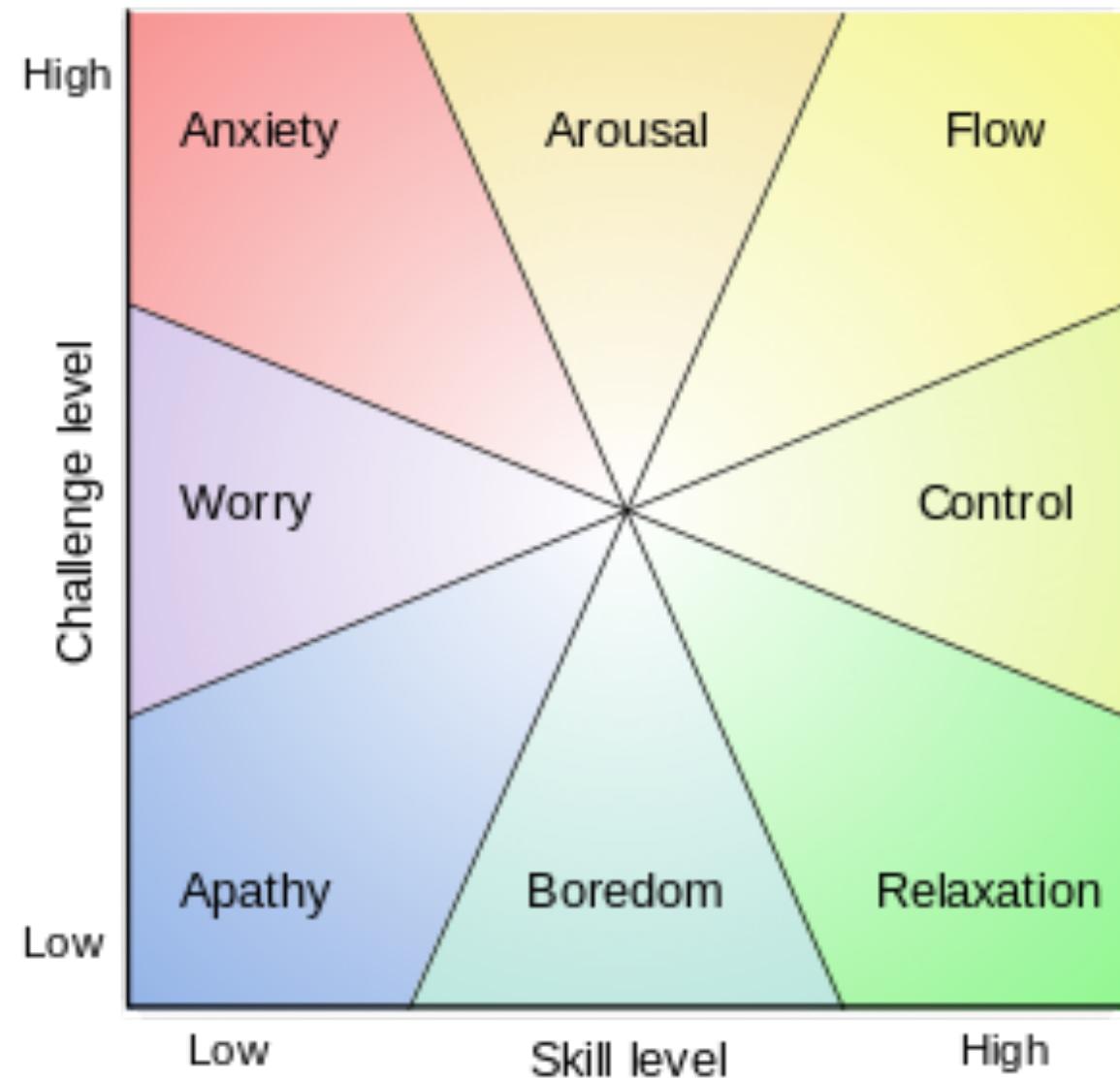
# Progression and Longevity

- Challenges can be...
  - Concurrent
  - Contiguous
  - Nested
- Good game design is about **generating a series** of interesting challenges
  - Player has inefficient means to achieve their objectives
  - Players become more skilled over time, more adept at using means
  - A “good” game is one where success of the player is largely determined by the skill of the player
- How should we balance rules and challenges in general for appropriate progression?
  - What are the parameters of the challenges
- How can we ensure or assess engagement?
  - How can we **evaluate** if our game is “correct”?

# “Flow” (Csíkszentmihályi)

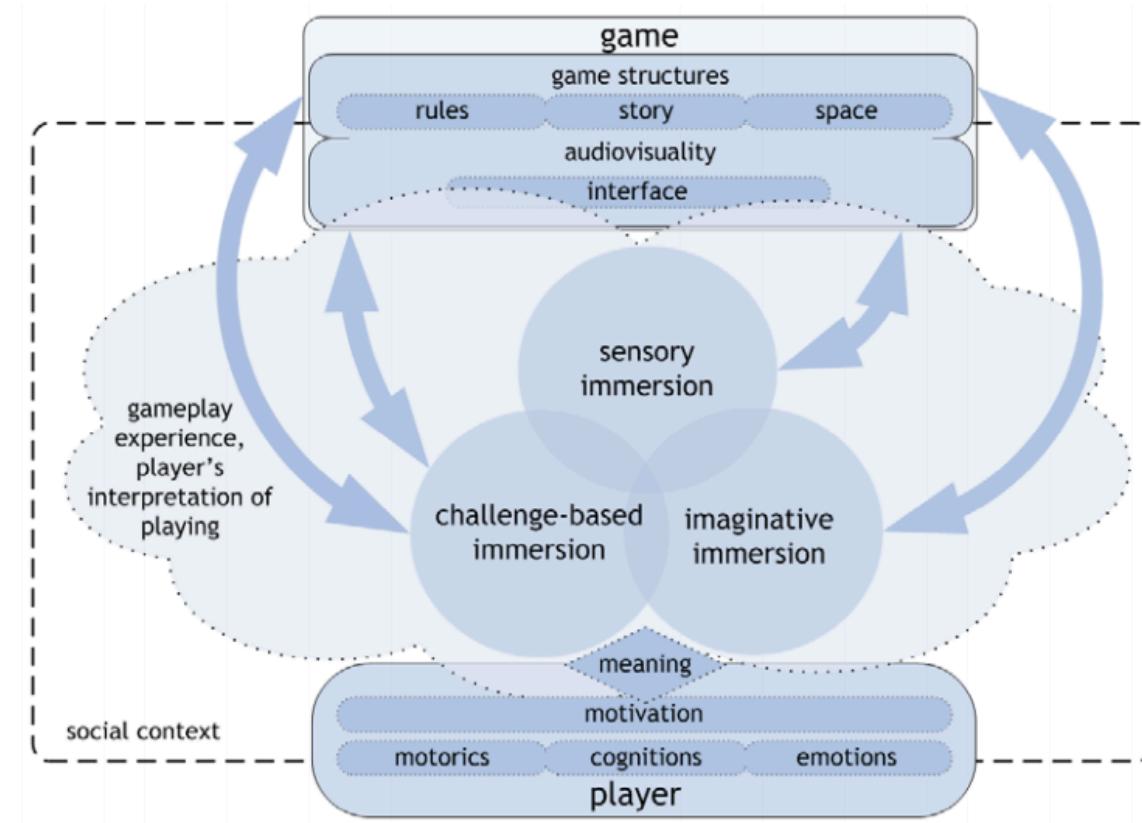
- The Psychology of Optimal Experience
- Elements of enjoyment
  - A challenging, rule bound activity that requires skills
  - A task that has clear goals, offers immediate feedback
  - An ability to concentrate on the task at hand
  - A perceived sense of control over actions, lack of a sense of worry about losing control
  - Merging of action and awareness, a state of deep and effortless involvement
  - A loss of self-consciousness or preoccupation with self
  - The transformation of time





# “Immersion” (Ermí & Mäyrä)

- The degree of involvement or engagement
  - Challenge-based immersion
    - Cognitive and motor requirements
  - Sensory immersion
    - Perceptual impact of multi-sensory properties
  - Imaginative immersion
    - Imaginary game world



# Levels of Immersion (Brown & Cairns)

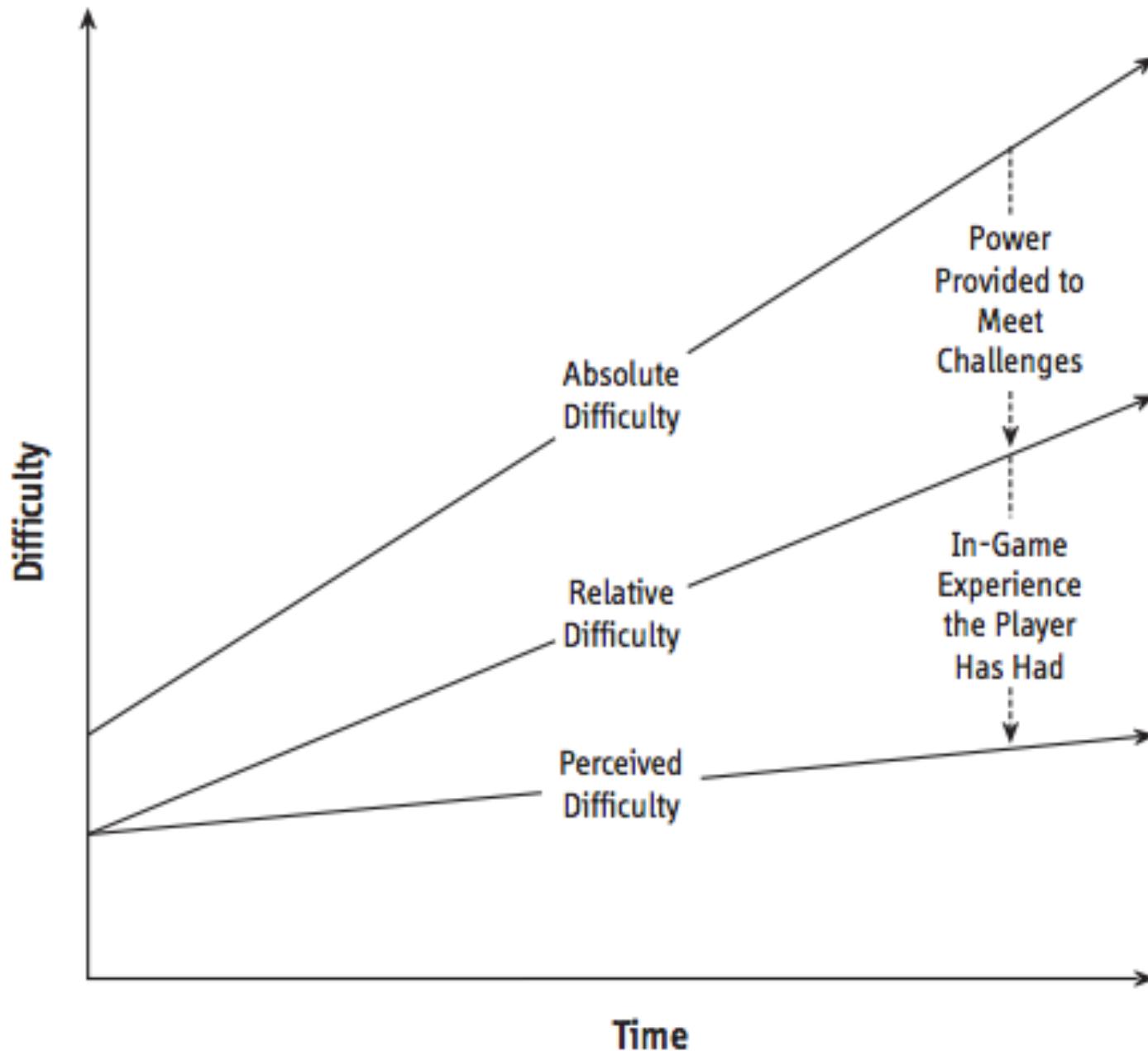
- Engagement
  - Willing to invest time, effort, attention
  - Does the player like this genre of game?
  - Expected effort = expected reward
  - Losing track of time = a feeling of guilt
- Engrossment
  - “Game construction” directly affects player’s emotions
  - High level of emotional investment
  - Less aware of surroundings
  - Distraction free environments
- Total immersion
  - C.f. “Presence”
  - Stop thinking about the fact that a game is being played
  - The game is all that matters
  - Empathy with game characters
- Brown, E. and Cairns, P. A grounded investigation of game immersion

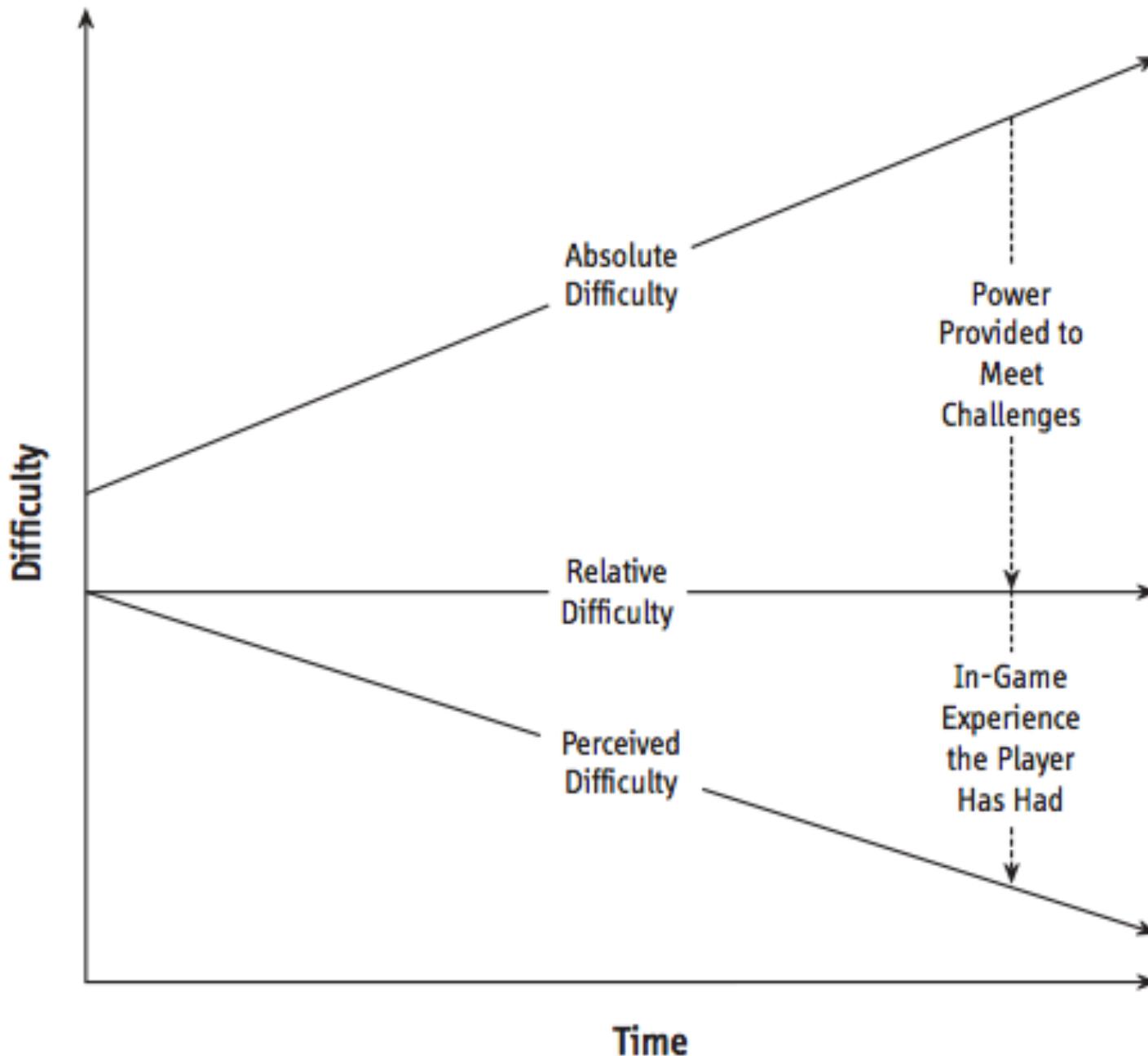
# Measuring Game Experience (IJsselsteijn)

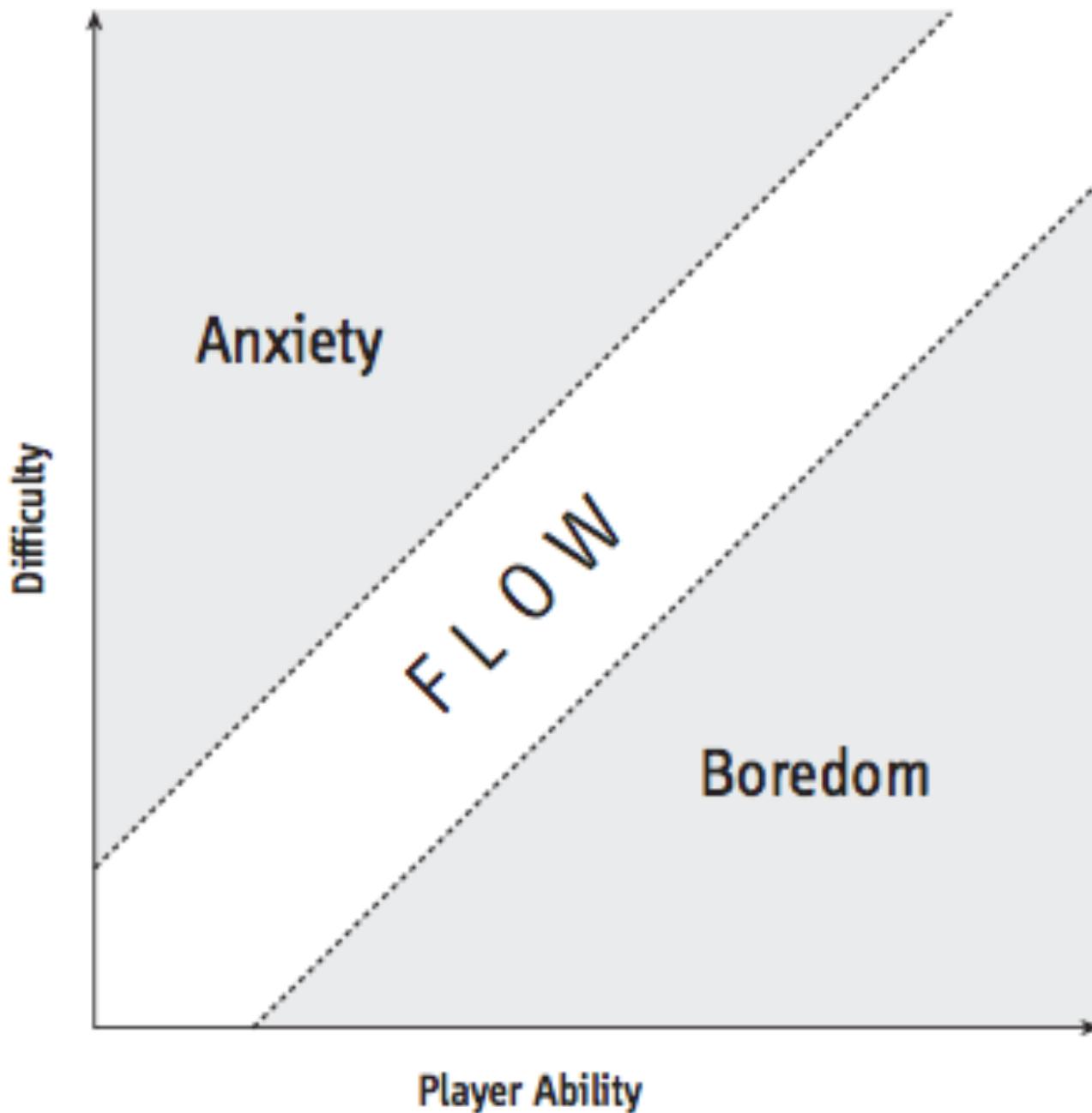
- Game Experience Questionnaire
- IJsselsteijn, W.A.; de Kort, Y.A.W.; Poels, K.
- Seven factors of experience
  - Sensory and imaginative immersion
    - It was impressive, I was interested in the story
  - Tension
    - I felt frustrated, I felt pressured, I felt tense
  - Competence
    - I felt strong, I was good at it, I felt skillful
  - Flow
    - I lost track of time, I forgot everything around me
  - Negative affect
    - I felt bored, distracted, it gave me a bad mood
  - Positive affect
    - I felt good, I enjoyed it
  - Challenge
    - I thought it was hard, I felt that I was learning

# “Difficulty”

- Actually *how challenging* is it?
  - A trivial enemy: stands still, could not harm the player, could be killed with one hit
  - A non-trivial enemy: moves around, hits the player, requires multiple hits
  - **Absolute** difficulty
    - The intrinsic skill required and the stress of the challenge compared to the trivial case
- What is the *power provided*?
  - How much damage can the player do with a single hit
  - **Relative** difficulty
    - The difficulty relative to the player’s power to meet the challenge
- How does the player’s intrinsic skill change over time?
  - How much time has the player spent meeting similar challenges
  - **Perceived** difficulty = **absolute** difficulty – (power provided + in-game experience)

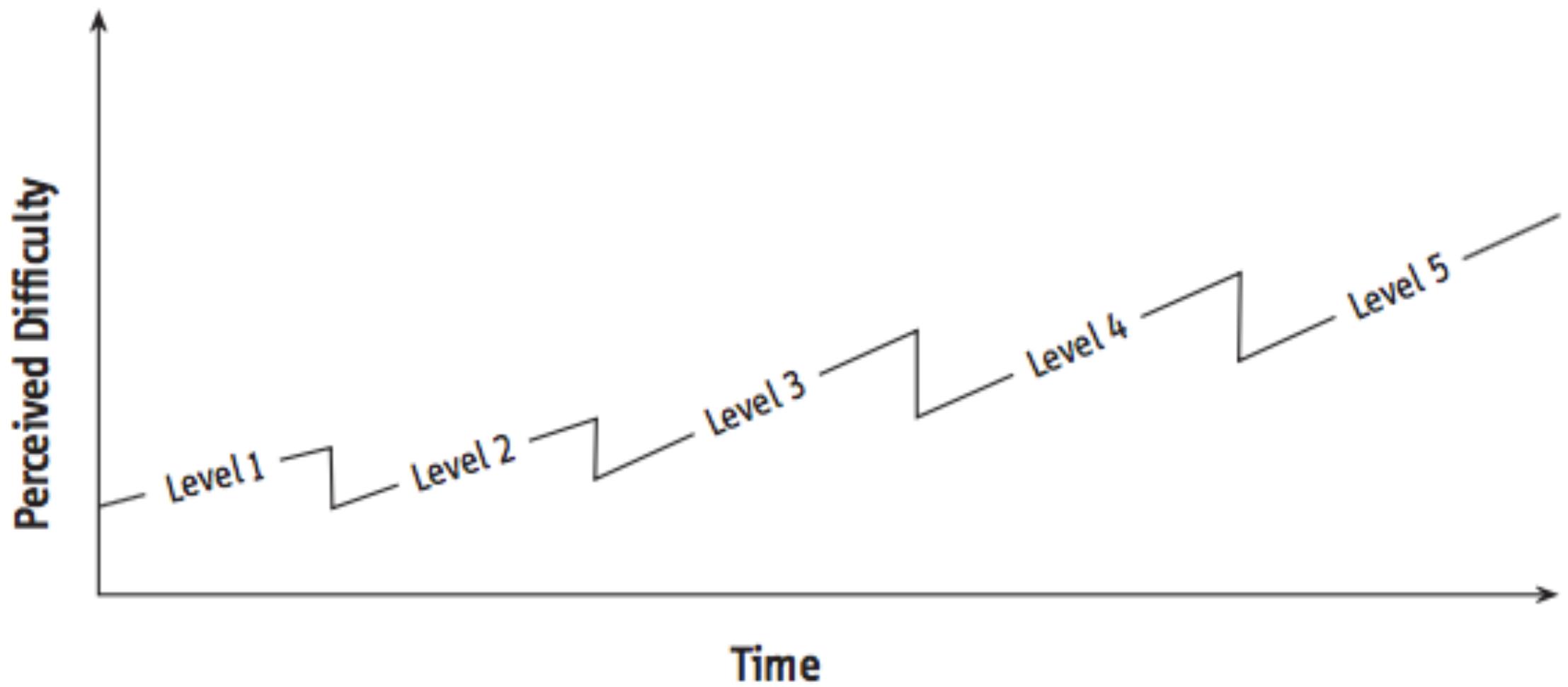




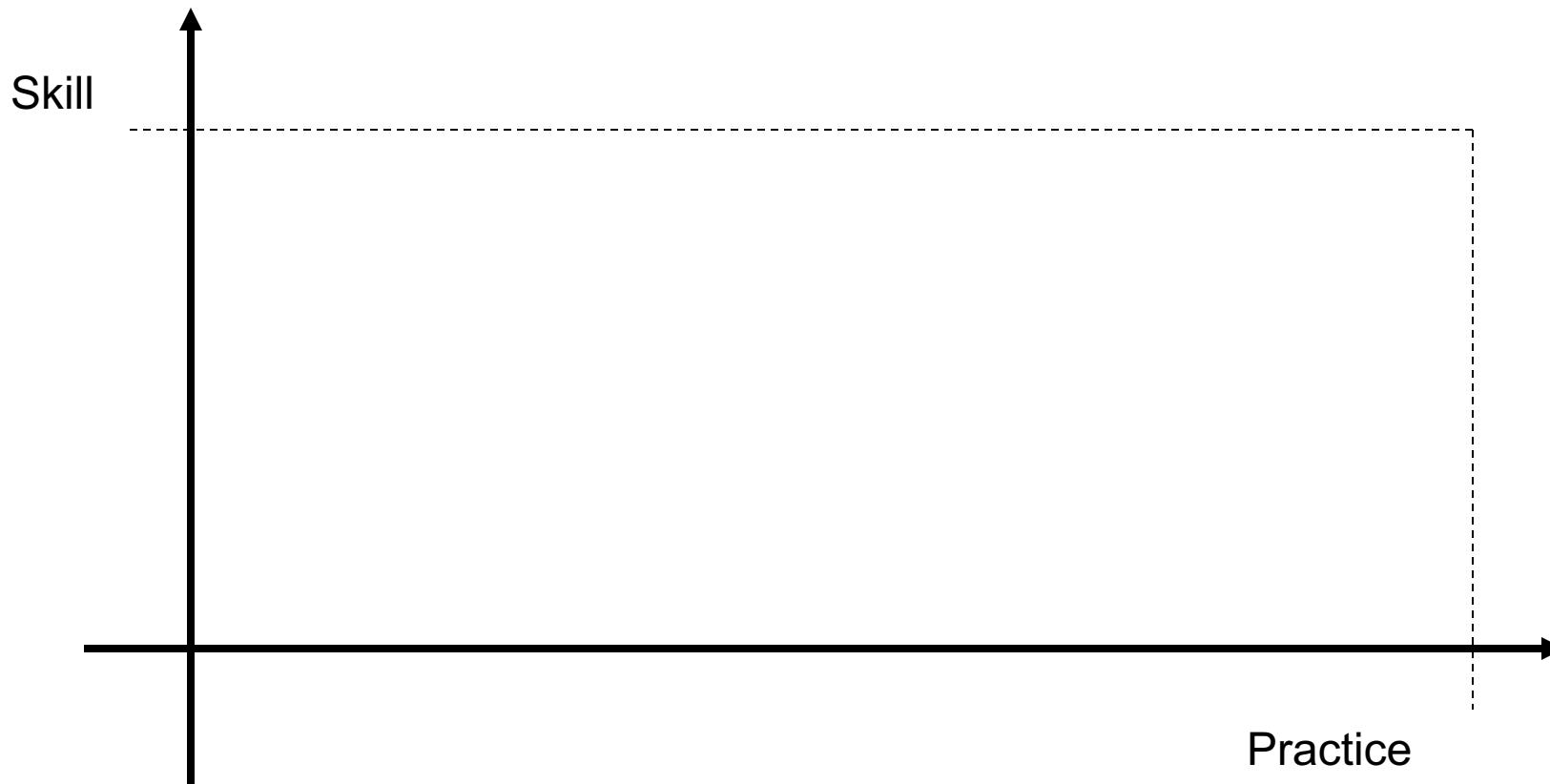


# Progression

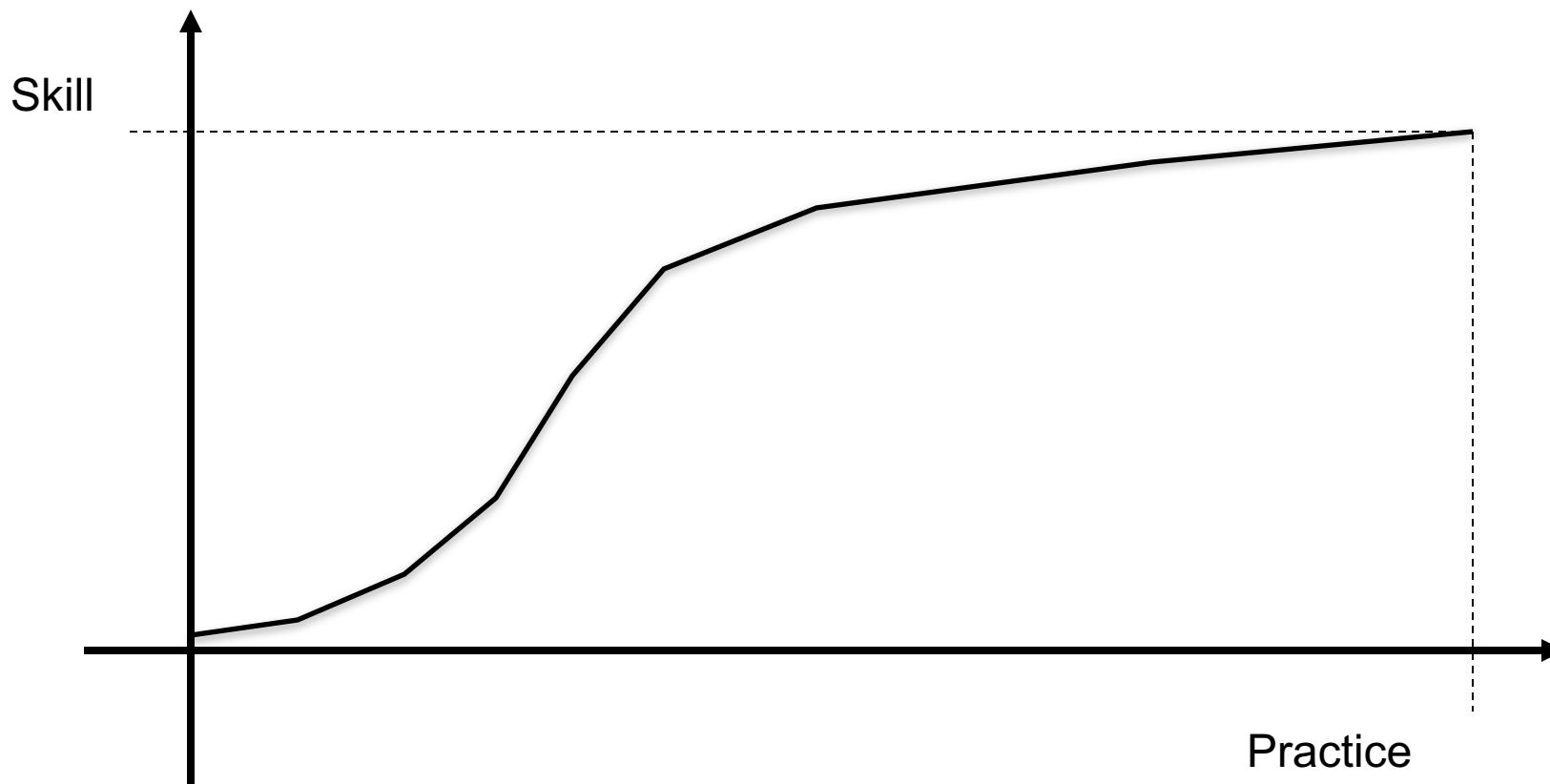
- Design should exhibit *progression* of some kind
  - Changes from level to level that represent growth in some form
    - Narrative advancement
    - Character growth
    - Longer levels
    - Difficulty increase (dynamic difficulty)
  - The perceived *difficulty* of challenges presented to the player either should not change or should rise, so the player feels that later challenges present greater difficulty than those at the beginning
- Frequency of challenges determines *pacing*
  - Alternate between fast and slow periods

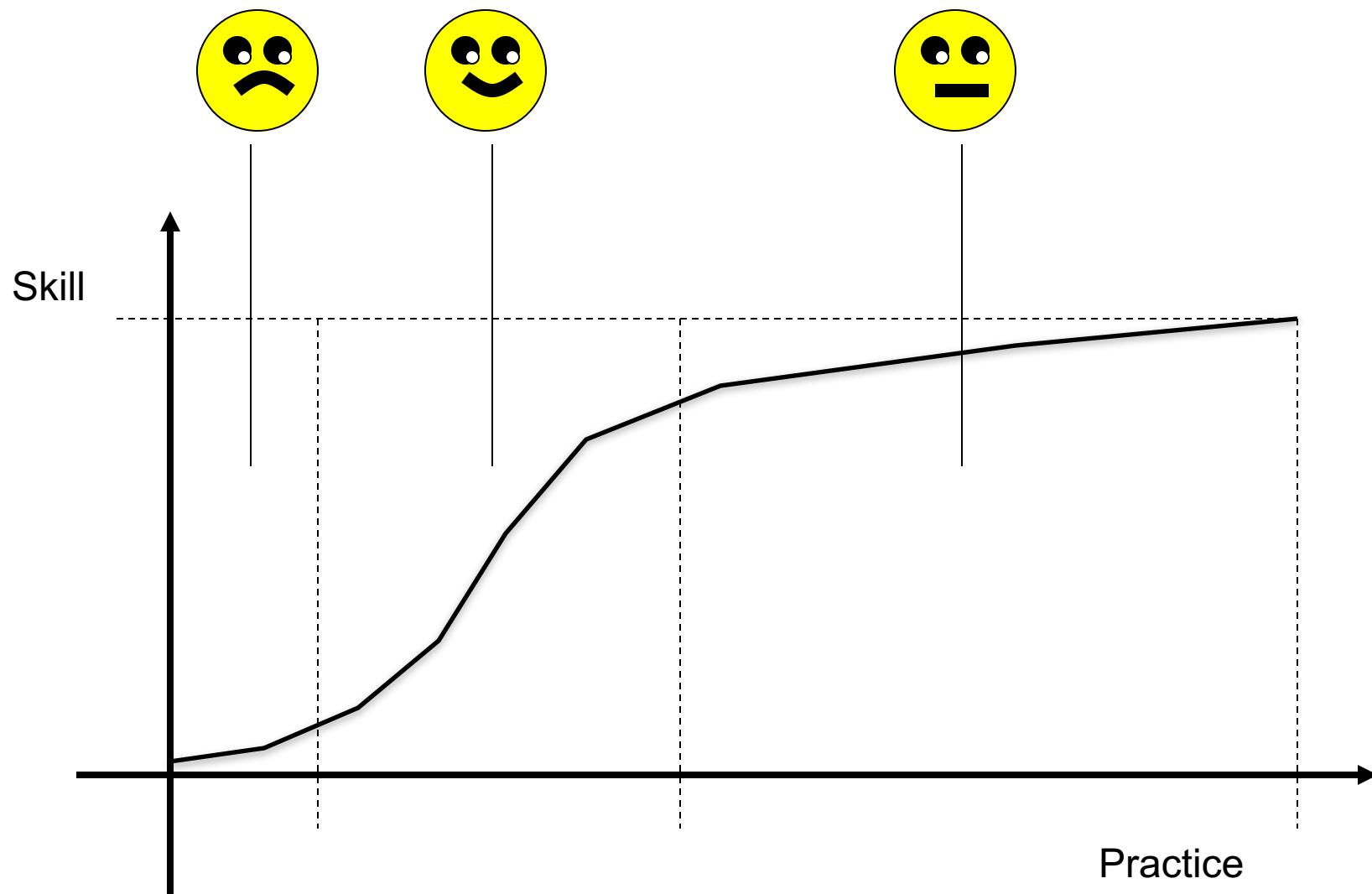


# Skill increases with practice



# Skill increases with practice





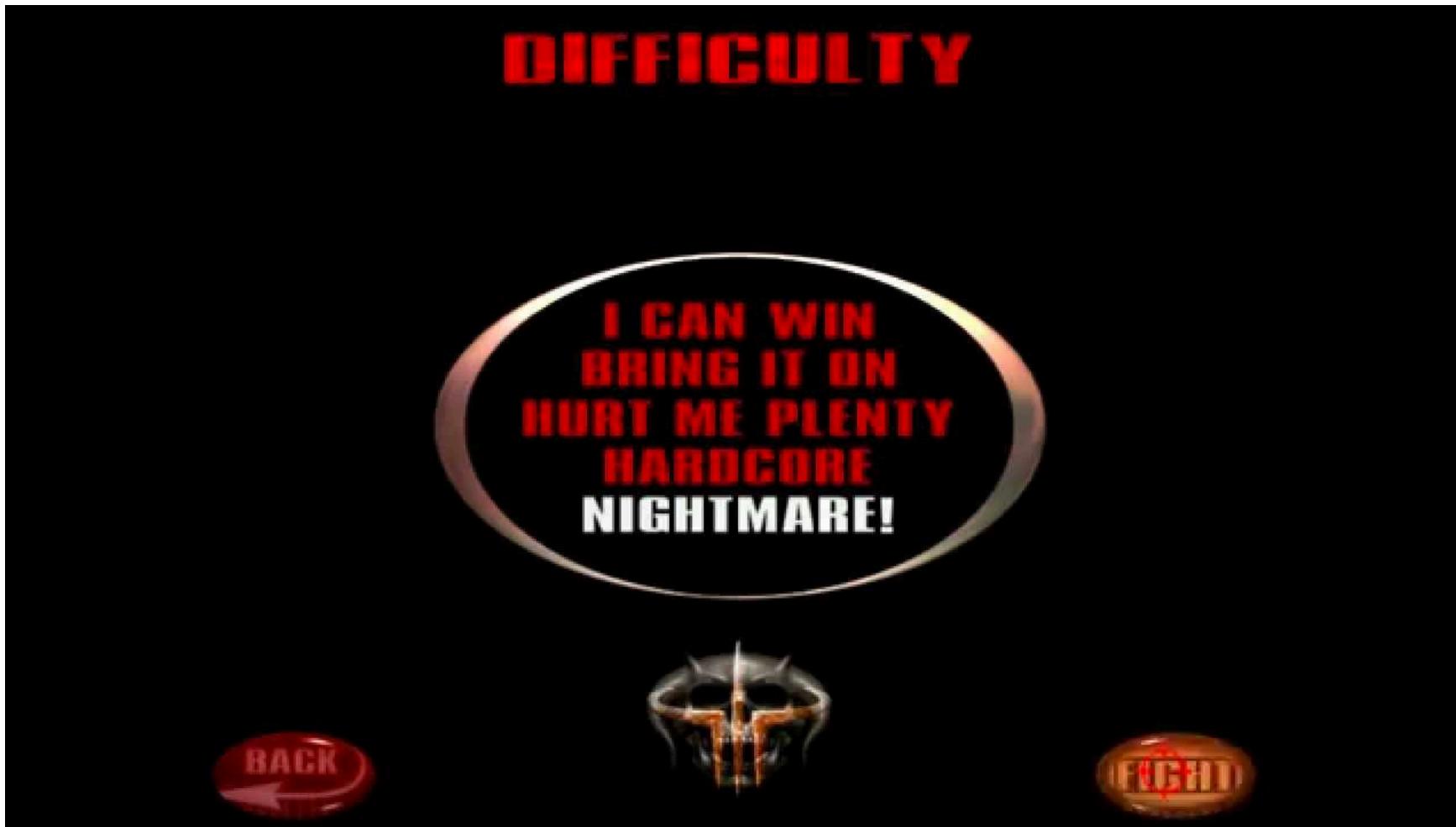
# Progression

- Stage 1
  - Slow progress, high frustration
  - A lot to learn, freedom to make mistakes without punishment
  - Design should support the player in gaining a sense of control
- Stage 2
  - Skill increasing
  - Aware of success
    - Merging of action and awareness
  - Ideal state, extend for as long as possible
- Stage 3
  - Mastery of the challenge
  - Boredom
  - Unlikely to complete the game

# The Last Guardian (2016)

- <https://youtu.be/xGJOPKnCi88?t=360>

# Quake 3 Arena (1999)



# Tomb Raider II (1997)

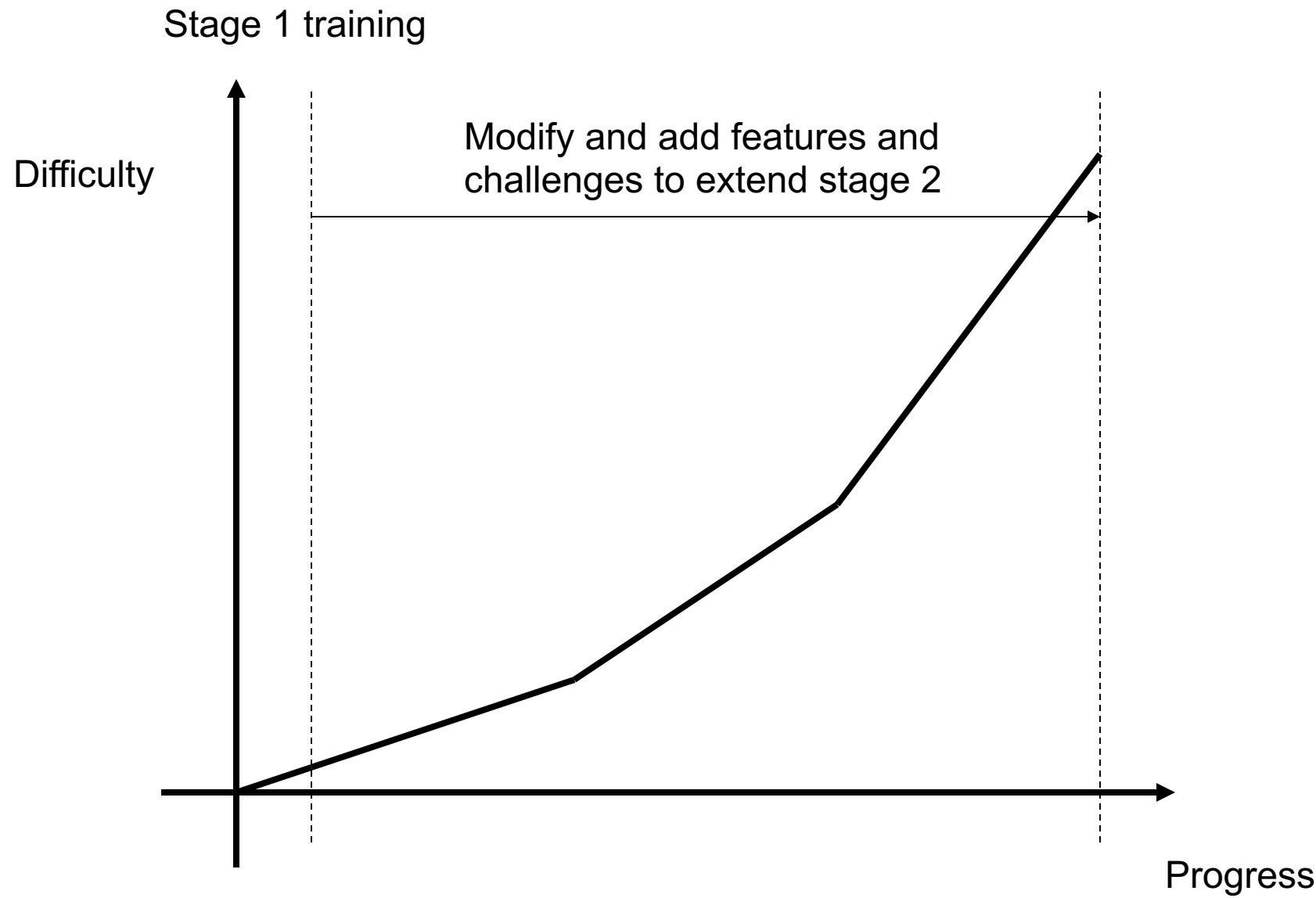


# Half Life 2 (2004)



# Half Life 2 (2004)





# Progression

- Skill “gates”
- Exploration
  - Unlock new areas
  - Re-use an existing area with new challenges
  - New opponents, obstacles and environments
- Conflict
  - New abilities
  - *Reset* of ability
  - New opponents and obstacles
- Economy
  - Increase resource scarcity
  - Crafting and skill trees
  - Harder opponents and obstacles
    - Require greater skill to overcome, increase in power, greater ability / accuracy





# Poor Progression

- Equivalent Features
  - Look different, but perform a very similar function to an existing feature
  - Different coloured enemy
    - Sensory immersion?
- Arms Race
  - Player gets more powerful, enemies get more powerful
  - Game play and challenge does not change
    - Sensory immersion?
- One Trick Pony
  - A challenge that is completely different to previous challenges, does not fit with the game genre
  - Racing game that suddenly requires puzzle solving

# Simple Progression Dynamic

- Create a number of challenges or levels and group by difficulty
- Easy
  - All players should be able to complete these challenges
  - Design for those who are new to the genre
- Medium
  - Most players should be able to complete these challenges, including the game designer
  - Design for casual players
- Hard
  - Good players should eventually be able to complete these challenges

# But is it balanced?

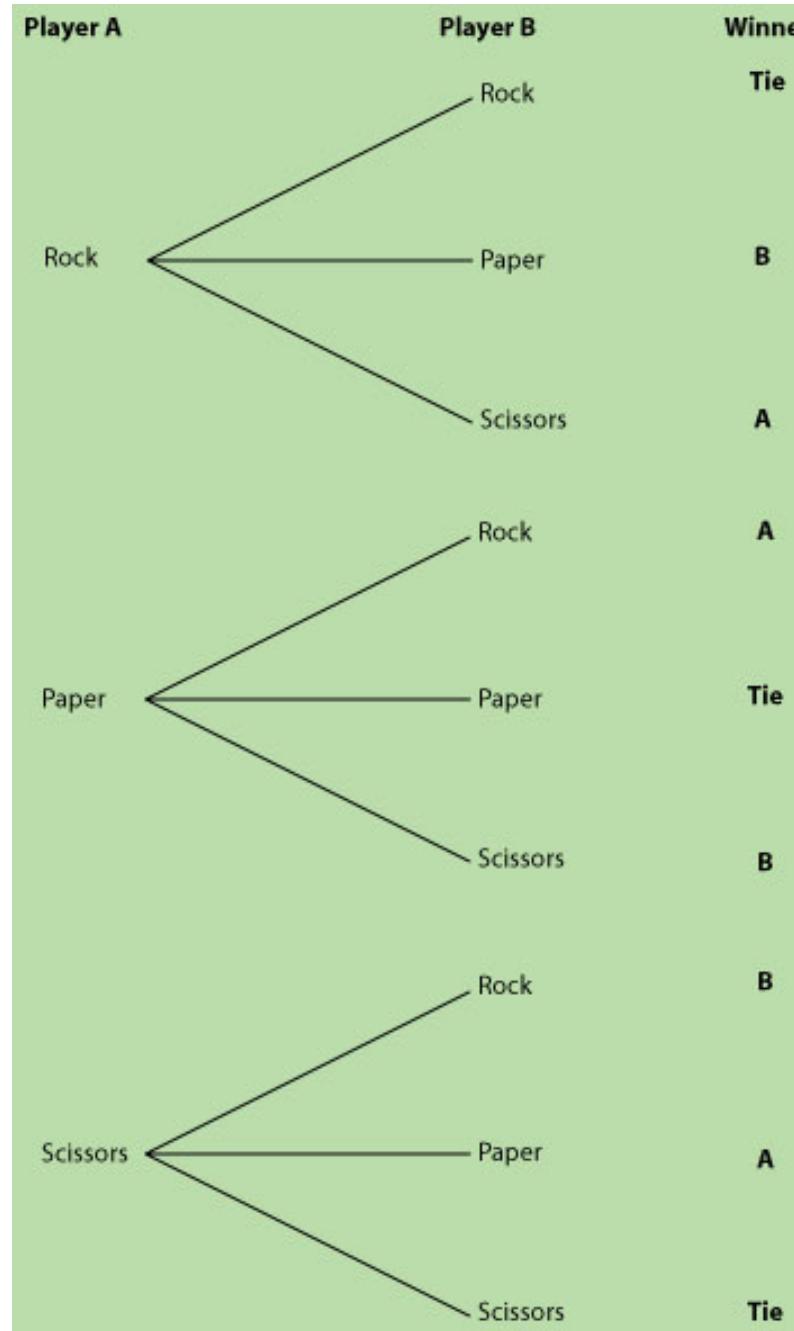
- Contains meaningful choices
- The role of chance is not too great
- Perceived to be *fair*
- Player-versus-Environment
  - *Appropriately* challenging: neither too hard nor too easy
  - Balanced resources: actions are not too “expensive”
  - No dominant strategy: requires multiple play styles
- Player-versus-Player
  - Fairness: equal players have equal chance of winning
  - Pacing: players have “reasonable” chance of catch-up
  - Politics: skill should be more important than alliances

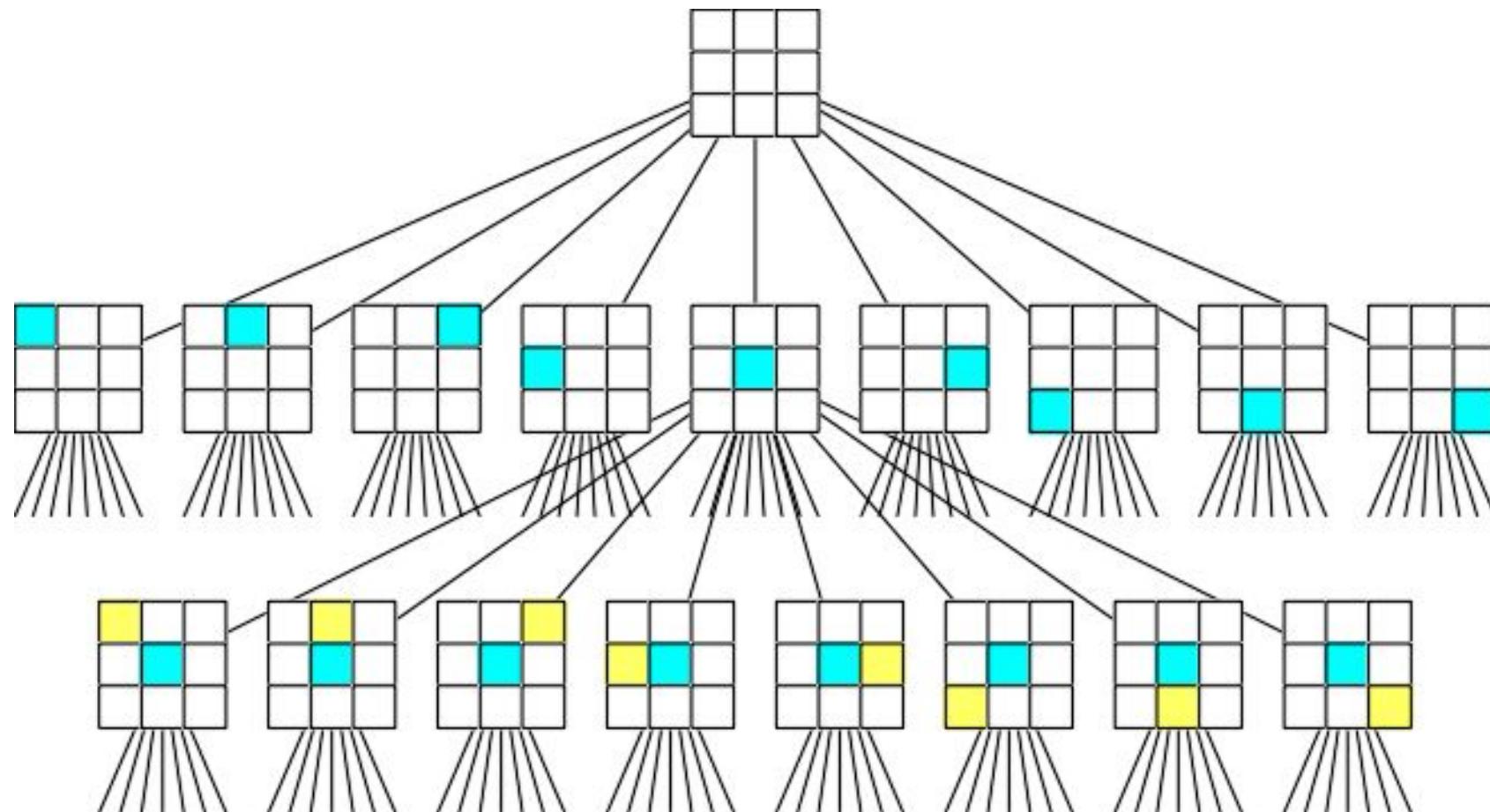
# Balance

- Can make or break a game
  - May look, sound and even play well
  - Can still be a failure
  - We may have all the formal and dramatic elements of game play
    - Need to be in balance with one another and the player
    - Game fails if they are not, no fun
- A **balanced** game is one where success of the player is largely determined by the skill of the player
  - Random events may occur
  - In general a better player should get further than a poor player
  - Could think of balance as inherent advantages and disadvantages

# Is it balanced?

- Combinatorial analysis of the game components
  - Optimisation problem
  - Just because a result is mathematically correct does not mean it is aesthetically interesting
- Trial and error
  - Run out of time, release game
  - Tweak further by releasing additional patches
- Need to understand what we're balancing and how
- **Static** balance
  - Are the rules fair when considered as a static system?
  - Is the initial state of the system (formal) balanced?
- **Dynamic** balance
  - Is an equilibrium maintained?
  - How does balance change with time and player interaction?





# Birthday Conundrum

- If it is my birthday, and you buy me a present, you win 10 points, because you remembered my birthday.
- If you don't buy me a present on my birthday, I will be upset, and you will lose 100 points.
- If it's not my birthday, you win 20 points, because you have surprised me with your thoughtfulness.

# Birthday Conundrum

	Birthday	Not Birthday
Buy present	10	20
Do not buy present	-100	0



# Rock, paper, scissors – is it balanced?

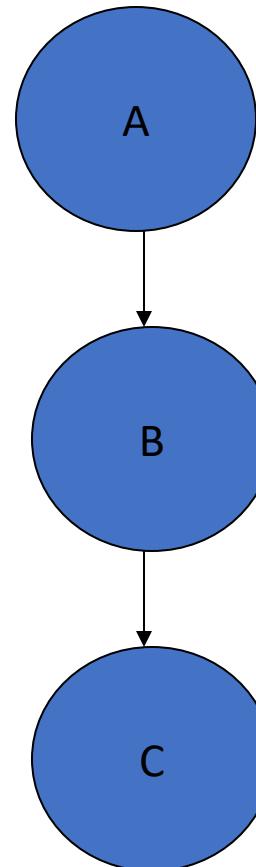
	Scissors	Paper	Rock
Scissors	0	1	-1
Paper	-1	0	1
Rock	1	-1	0

# Dominant Strategies

- Always buy presents
  - Always get positive payoff
  - Assuming there is no “memory” in the system
    - Rarely is in a game mechanic
- Never buy presents
  - Zero payoff
  - Massive loss
- **Strongly** dominant strategy
  - Guarantees winning every time
- **Weakly** dominant strategy
  - Guarantees not losing, but drawing – Tic-tac-toe
- All other strategies **recessive**
  - Why would a player choose to do something else?
  - Once discovered, they never have cause to use any other strategy

# Transitive Relationships

- A one-way relationship between objects
- A beats B, B beats C, C beats nothing at all
  - Therefore A beats C
    - Transitive property of “beats”
- Why would anyone want C?
- Examples?

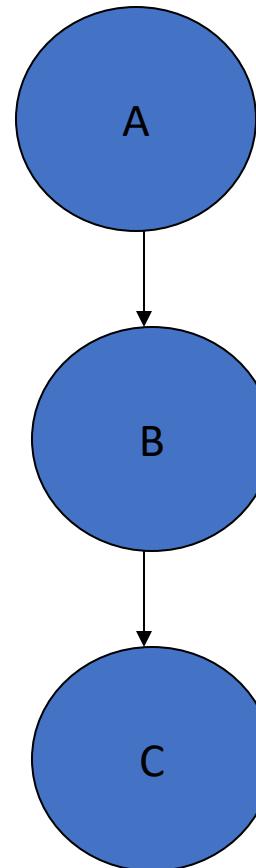


# Transitive Relationships

	A	B	C
A	0	1	1
B	-1	0	1
C	-1	-1	0

# Transitive Relationships

- Make C **free**, and A **cost** something
  - Literal resource cost
  - Effort required to achieve
- Reward without cost leads to a **dominant strategy**
- Transitive relationships continually drive a player towards a goal
  - Progression
    - Work from C up to A
  - Positive feedback
    - If you do well, you get better at doing well



# GARAGE



**BMW M3 E92**  
\$45000 [level 2]



YOU HAVE:

**\$439568**

**RP: 41122**

FILTER CARS:

**LEVELS 7,8**



**SELL UPGRADE PAINT RACE**

POWER

307 kW

WEIGHT

1680 kg

GRIP

9513

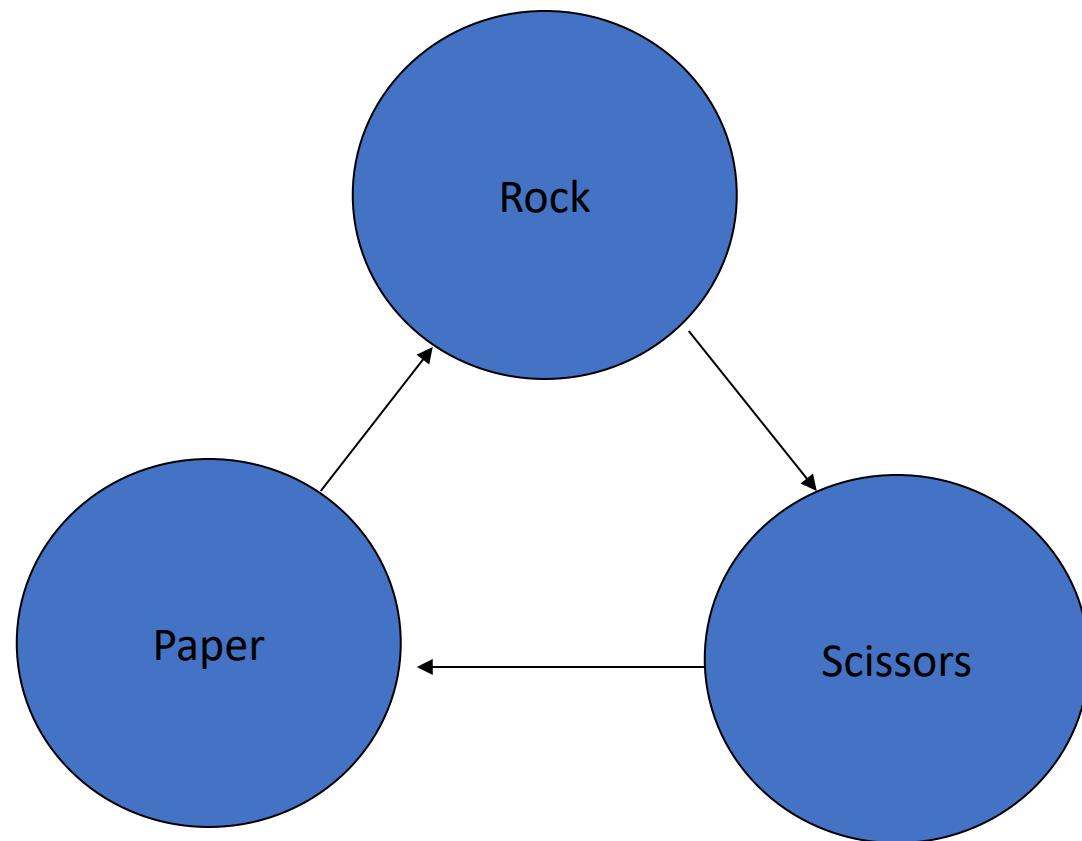
# Transitive Relationships

- A racing game in which players attempt to earn the most prize money by winning races
- Car speed Porsche > BMW > Fiat
  - Dominant strategy
  - Solution
    - Price each car in proportion to its advantage
    - \$\$\$Porsche, \$\$BMW, \$Fiat
    - The financial disadvantage of the Porsche offsets its speed advantage
    - Bland?
- Shadow costs
  - Build the cost into the game *mechanics*
    - A slow rate of fire to offset large amount of damage
    - Only discovered when starting to use the weapon
- Games involving upgrading or augmenting player abilities
  - Positive feedback
  - Regression
    - Loss of upgrades
    - Dramatic effect

# Quake 3 Arena (1999)

- <https://youtu.be/rSOChyMURXM?t=19>

# Intransitive Relationships



# Intransitive Relationships

	Scissors	Paper	Rock
Scissors	0	1	-1
Paper	-1	0	1
Rock	1	-1	0

# Intransitive Relationships

- No strategy always wins
  - Monotonous play is punished
  - Play becomes psychological
- Common in RPGs
  - “Trade off” one ability against each other
    - The player must decide which ability to maximise
      - Speed vs durability
  - Spend points on strength or charisma?
    - Stats-jugglings
    - Skills are independent and orthogonal
  - Still needs to be balanced
    - A strength point should give an equivalent advantage as a charisma point
    - Must still be able to complete the challenge
      - Arbitrary punishment for making the wrong decision

# The Rock, The Paper and The Scissors (2016)



# Orthogonal Differentiation

- Each type of unit a player can control should be *orthogonally different* from all others
  - Unlike the others in a different dimension
  - Differ in magnitude of power at performing a task
  - Display entirely different qualities
    - A distinct role to play in the game
    - Otherwise weaker units only serve as part of an upgrade path
    - RPG
      - Strength, intelligence, charisma...
- Avoids dominant strategies
  - A variety of units required to complete the level
    - Difficult to directly compare the advantages of weapon vs armour
  - Stealth & combat
    - Requires diverse *challenges*

# Balancing Techniques – Symmetry

- Only applies to PvP
  - Or PvE where the “computer” is embodied as a player
  - All PvE games are asymmetric because there is only one player
- Each player is given the same starting parameters / abilities
  - Most applicable to...
    - Sports simulations
    - Multi-player games
  - If a dominant strategy is available it is available to all
    - Starting turns governed by random chance therefore considered *fair*
  - Difficult to achieve precisely
    - Little in the “real world” is symmetric



# Balancing Asymmetry – Resources and Points

- **Quantify** abilities by reducing them to points
- Sources – how a resource can increase
  - Ammunition, health pickups
  - Spawn points
- Drains – how a resource can decrease
  - Firing a weapon, damage to the player
  - Killing a monster
- Adjust sources and sinks to *balance* economy
  - Together determine the *price* of the resource
  - Price of resource should reflect it's *power*
    - Skill + Power = *Agency*
- Failure states
  - Underpricing
    - Cheap, powerful actions limit play variety
  - Overpricing
    - Expensive, weak actions penalise usage, waste of designer's time
  - Engines
    - Spend one resource to get back another

# Balancing Asymmetry – Social Play Roles

Motive	Role of Player	Role of Counteractor
Race	To overtake	To stay ahead
Chase	To catch	To dodge or elude
Attack	Overpower a defense, to enter a guarded area	To defend an area, to ward off, to be on guard
Capture	To take person, position, symbol	To avoid being taken

# Balancing Asymmetry – Map Design

- Enhance and facilitate combat
  - Choke points
    - Enhance and facilitate combat
    - Narrow the map flow through 2-3 entrances
    - Before the map's objective
  - Both teams arrive at the same time
- Place bomb before counter terrorists arrive
  - Set up “defense”
- Support multiple play styles
  - Sniping, close combat, stealth



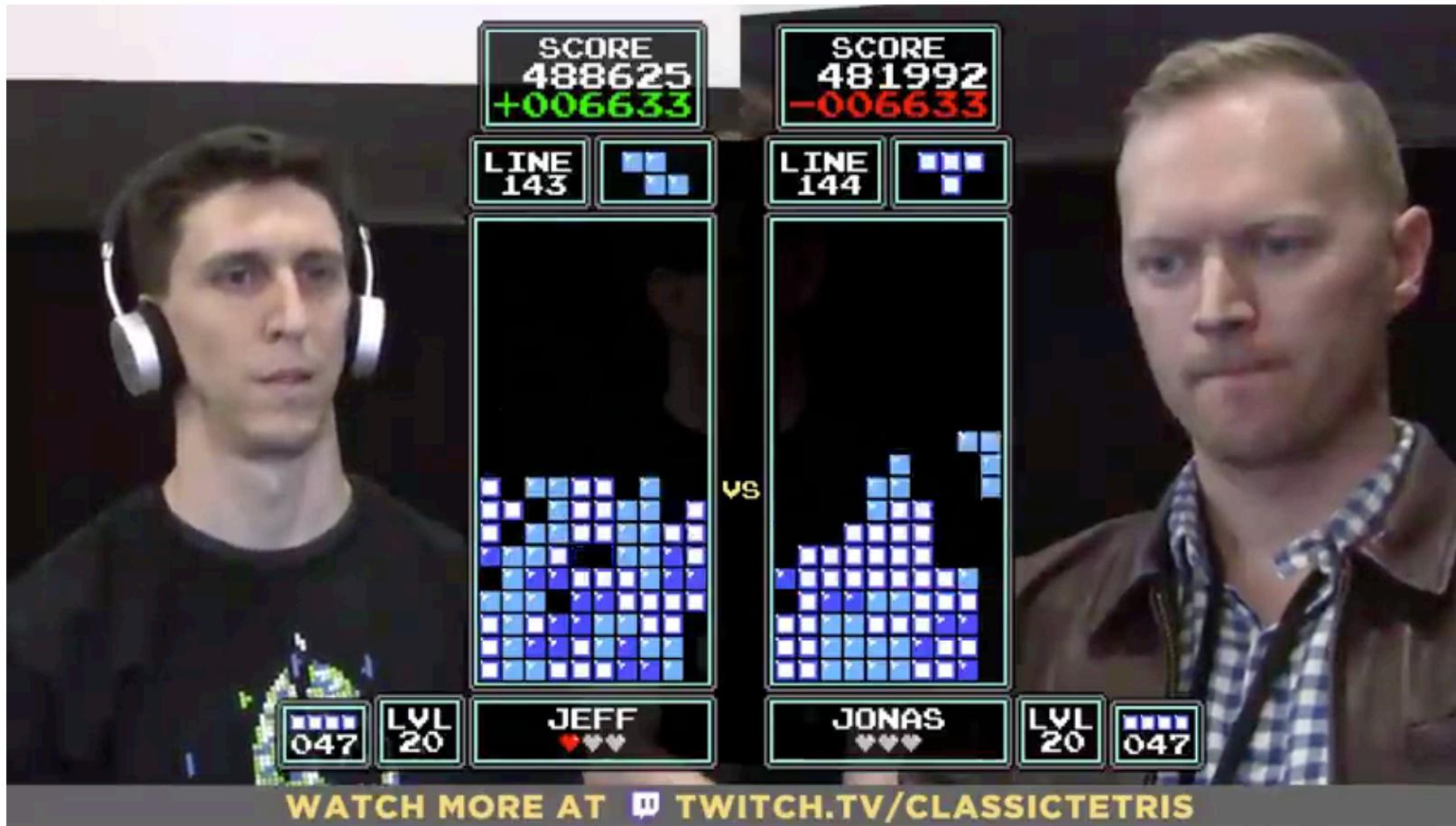




# Dynamic Balance

- As **time and player interaction** continue, what happens to the balance?
  - Is it maintained?
  - Is it destroyed?
  - Can it be restored?
- How the game is dynamically balanced defines the game play of the game
  - Balance is disrupted
    - The / a player wins or loses
  - Balance is maintained
    - The player can continue to play
    - Reach an *eventual* conclusion

# Tetris (1984-)

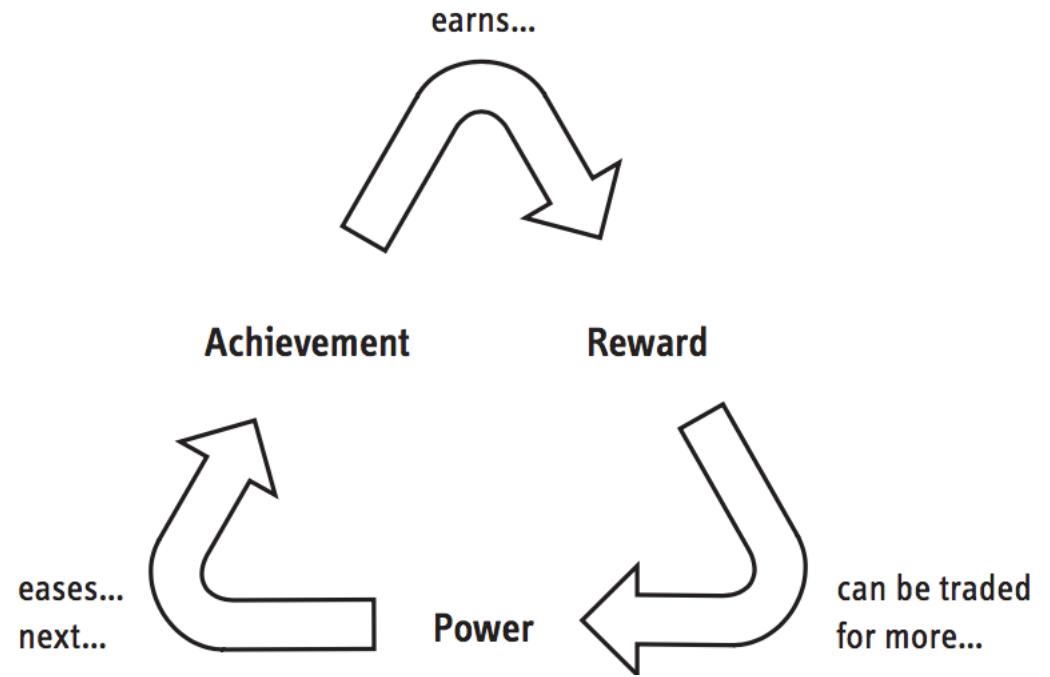


# Dynamic Balance - Longevity

- Longevity is a function of feedback
  - *Emergent or designed*
- **Positive Feedback**
  - Rewards player success
  - Leads to snowballing, destabilises the game
  - Can be constructive – increase attack ability
  - Destructive – drain opponent ability
  - Once a player gets ahead, difficult to catch up
- **Negative Feedback**
  - Punishes player success
  - Stabilises the game, forgives the loser
  - Can be constructive – boosts opponent
  - Game may go on forever without a winner
  - Winner may feel arbitrary

# Dynamic Balance - Pacing

- Feedback is a common form of dynamic, emergent behaviour
  - Game mechanics produce certain outputs
  - Outputs then modify the game mechanics
- **Positive**
  - Reward player for success
  - Power-ups / abilities in any shmup
  - “Stun lock”
    - Allow us to hit them again, “push home advantage”
- **Negative**
  - Handicap player for success
  - Blue shells in Mario Cart hamper the player in the lead



# Ultra Street Fighter II (2017)



# Need for Speed: Carbon (2006)



# Mario Kart (1992-2017)

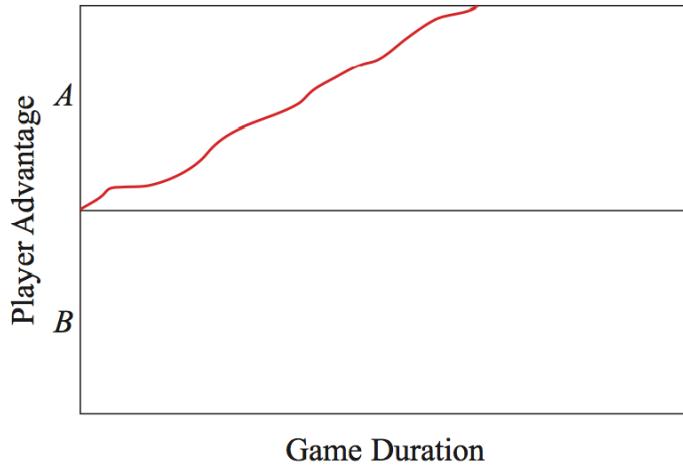


# Balancing Feedback

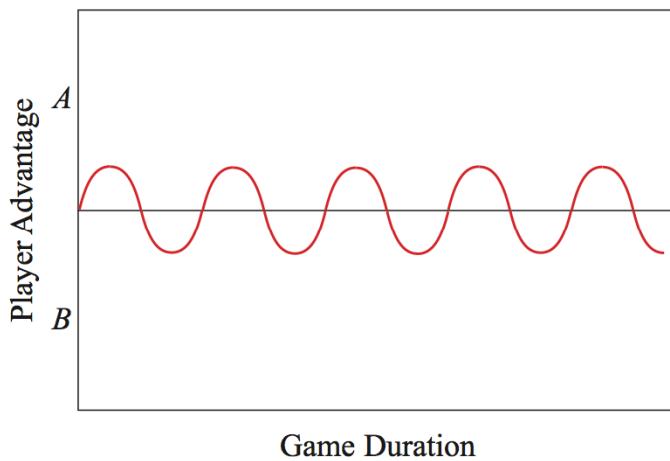
- Controlling positive feedback
  - Limit power as a reward for success
  - Introduce negative feedback
    - Associate cost with achievement
- Raise the absolute difficulty level of challenges as the player proceeds
  - Perceived difficulty remains constant
- Allow collusion against the leader
- Use the effects of chance to reduce the size of the player's rewards
  - “Random” loot lowers reward for achievement
  - *Half-Life 2* checks the state of the avatar's health and ammunition when a crate is opened, adjusts the contents of the crate accordingly

# Feedback failure states

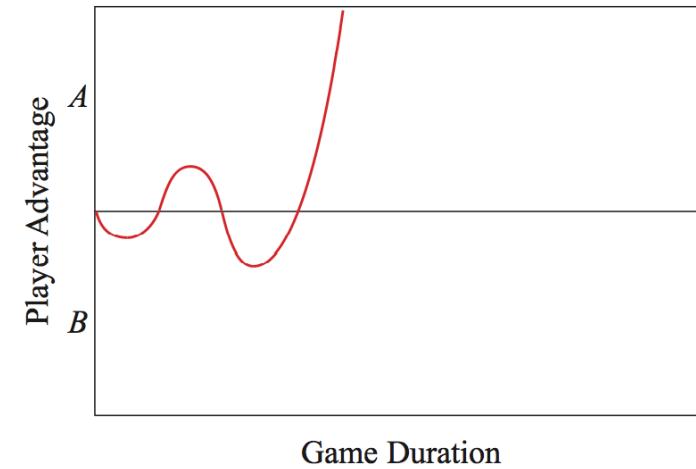
no feedback



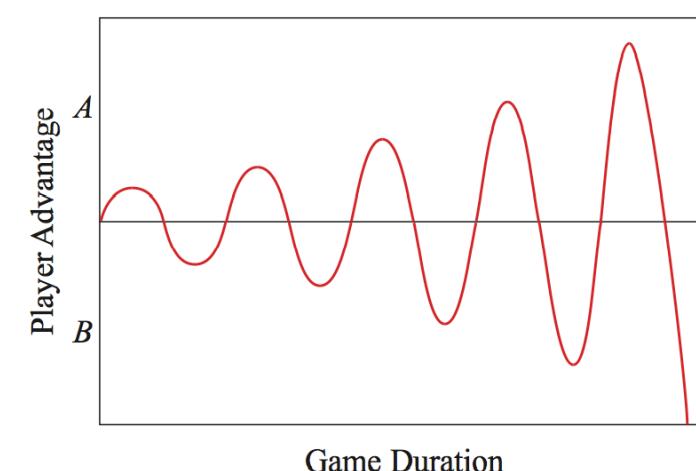
stagnation



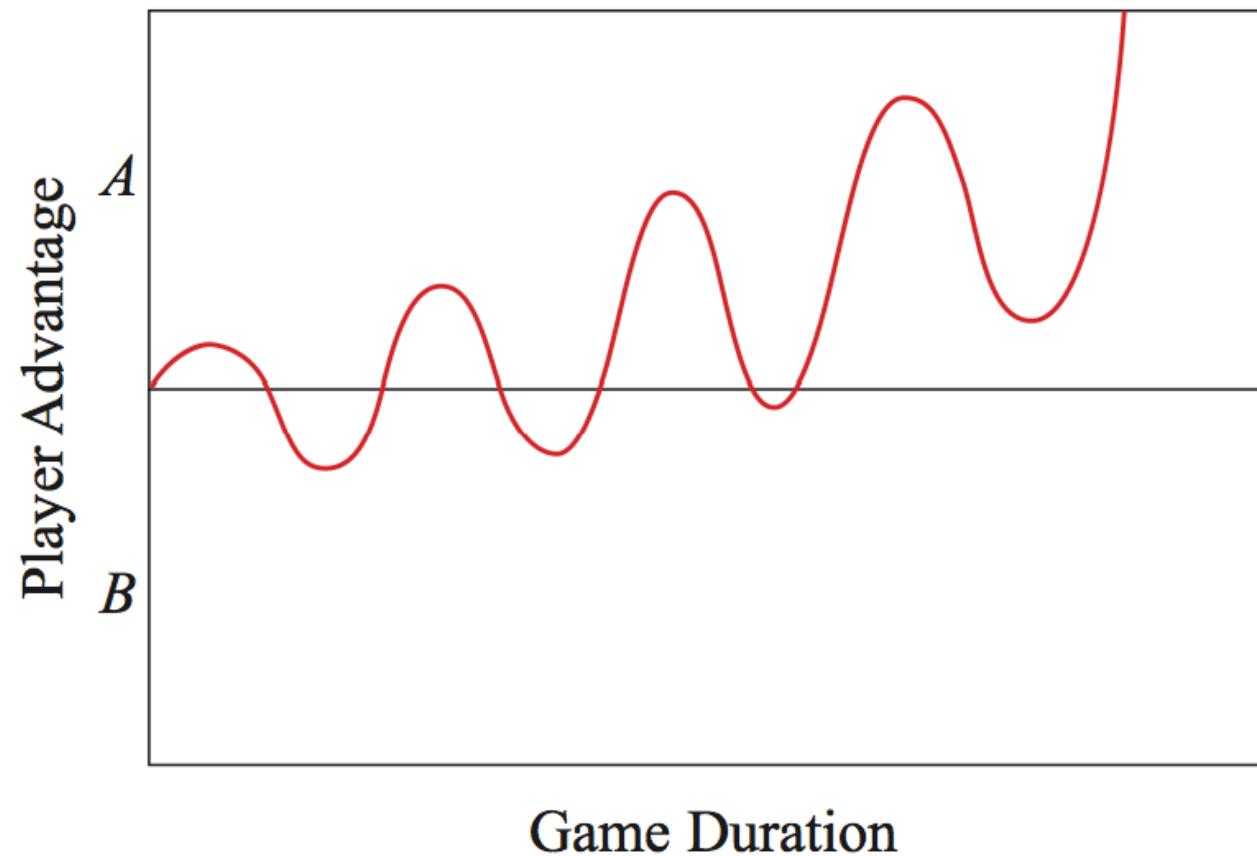
extreme positive feedback



extreme negative feedback



# Ideal pacing



# Parameter Tuning

- Mechanics have parameters
  - How fast the player can run
  - How far the player can jump
  - The power of an item or weapon
    - *Player efficacy*
- Tuning
  - Adjustment of these parameters
    - Dynamic feedback / dynamic difficulty
  - Allows you to adjust feedback
    - Feedback can be implicit, emergent – dominant strategy
    - How extreme should the effect of the “rubber banding” be?
- Requires significant play testing

# Reading

- The Concept of Flow. Csíkszentmihályi (2009)
  - <http://eweaver.myweb.usf.edu/2002-Flow.pdf>
- Fundamental Components of the Gameplay Experience: Analysing Immersion. Ermi & Mäyrä (2005)
  - <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.103.6702&rep=rep1&type=pdf>
- A grounded investigation of game immersion. Brown & Cairns (2004)
  - <https://dl.acm.org/citation.cfm?id=986048>
- Game Experience Questionnaire. IJsselsteijn et al (2013)
  - [https://pure.tue.nl/ws/files/21666907/Game\\_Experience\\_Questionnaire\\_English.pdf](https://pure.tue.nl/ws/files/21666907/Game_Experience_Questionnaire_English.pdf)
- Fundamentals of Game Design, Adams, chapters 11, 12
- Rollings and Adams, chapter 8.
- Salen and Zimmerman, chapter 18.