

SUPER MARIO BROS.

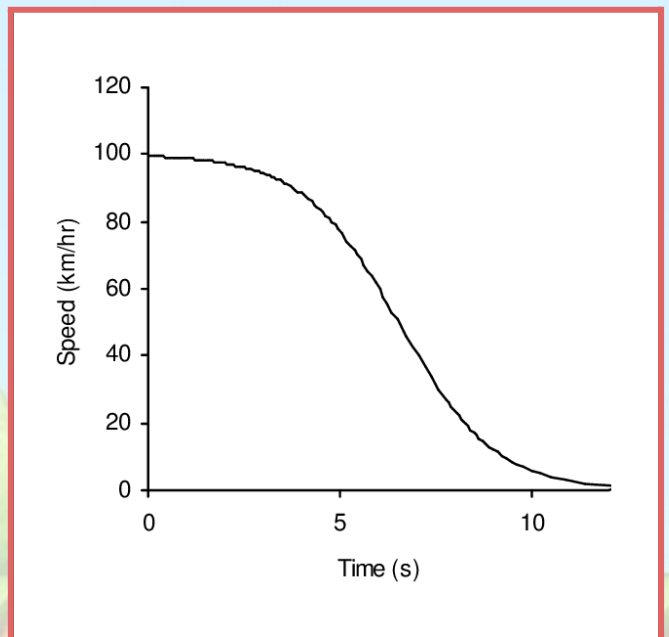
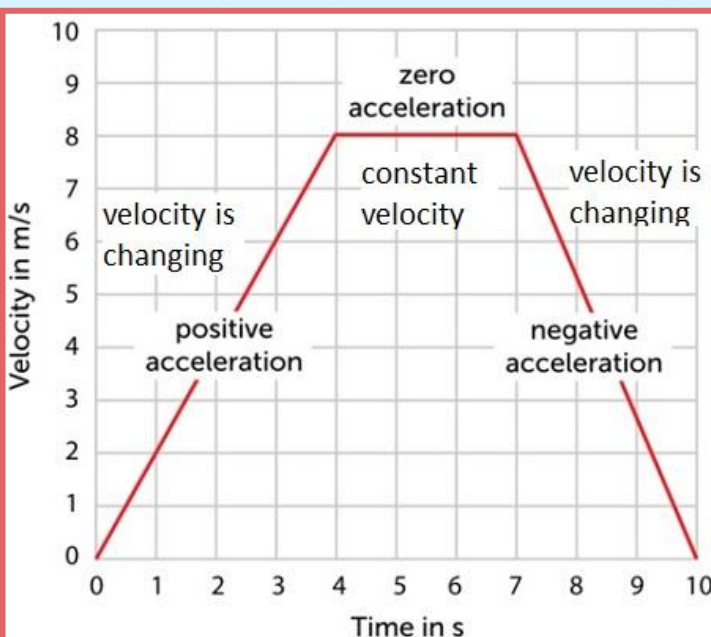
DASH: CHALLENGE ANALYSIS

For analysis purposes, the **added challenge** is that of **Horizontal Dash**, a game verb that allows Mario to have an **impulsive horizontal speed boost**. The challenge allows the player to increase his control over the character's **aerial movement** by **prolonging the time and distance that can be traversed in the air**. In terms of interaction, the dash does not provide any power ups to Mario, leaving him vulnerable to the obstacles and enemies present in the level. The **reset of the dash** occurs like that of the jump, i.e. when the protagonist lands on a surface (**floor, obstacle or enemy**).

Challenge Evolution

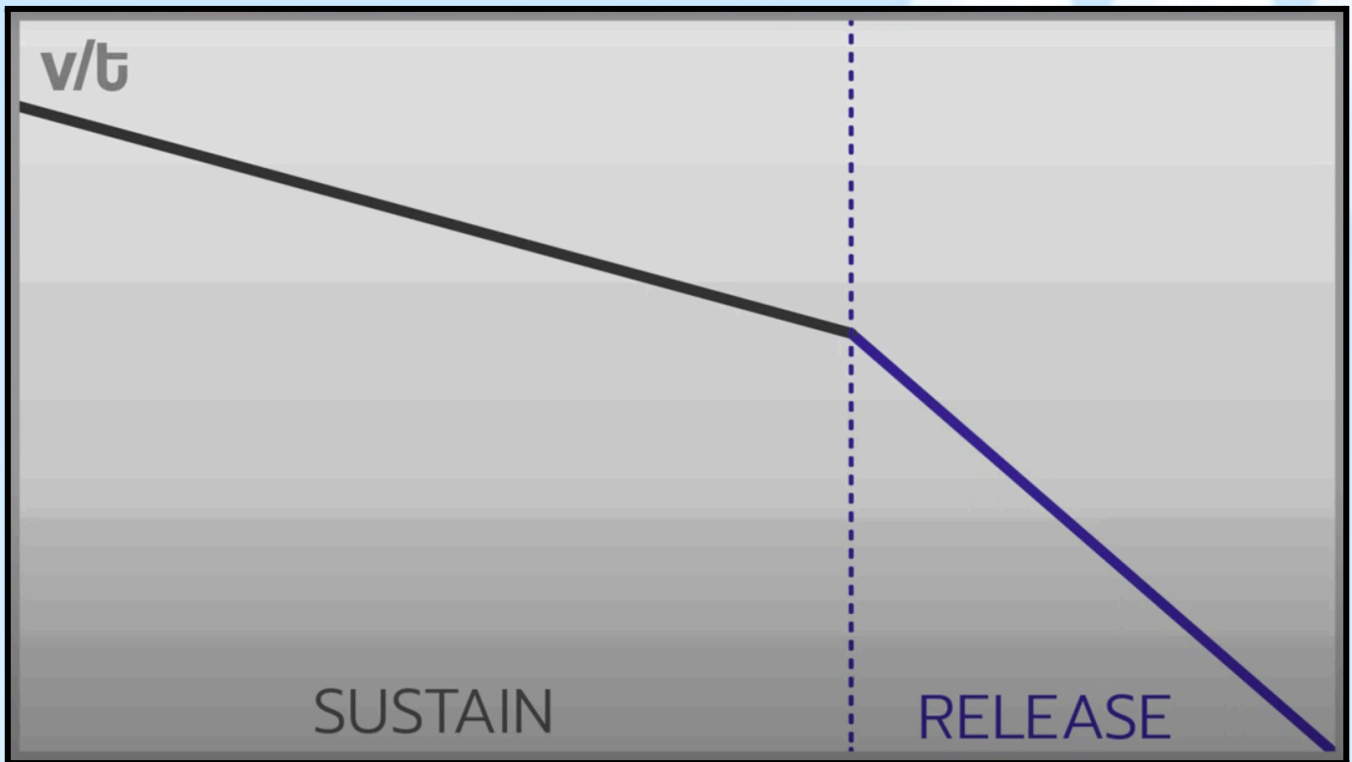
The **evolution of the dash** depends on the **player's reaction time regarding the dash reset** (execution timing) and on the **frequency of gameplay interactions** that involve the use of the inserted system. The level design **context** establishes the **variations of the atomic parameters** of which the dash is composed, i.e. the time (**t**) in which Mario's gravity will be deactivated and in which he maintains a constant speed in the air or on the ground (**acceleration = 0**, **initial acceleration** pulse and **deceleration** during progress) and the distance (**s**) traveled after pressing the button.

The **resultant** of these variables is **Mario's dash velocity (v)**. The $v = s/t$ **ratio** allows the designer to fine-tune the levels as to when the mechanics allow the player to obtain **progression**.



Input Response

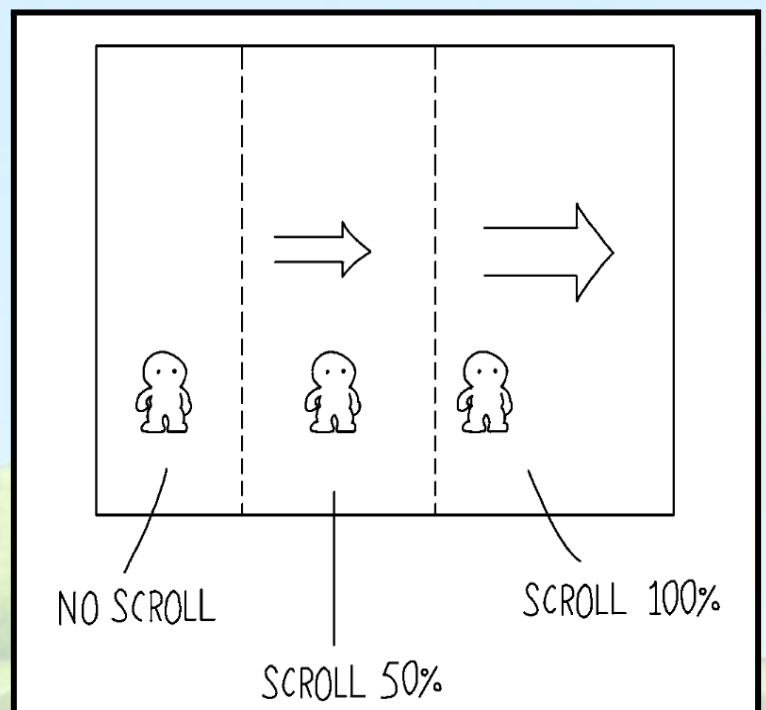
The **input responds the same way as the jump**. The pressure provides Mario with a **pre-established acceleration** which allows him to obtain an **instant boost in horizontal speed**. During the **sustain time** of the button (*kept pressed*) the **deceleration given by friction and gravity is slowed down**, giving the player the possibility of **covering a greater distance in a longer time**. As soon as the player releases the button, the speed returns to constant and gravity is reactivated, bringing Mario down if he is in the air.



Camera Scroll

An added difficulty for the dash player is the **camera**. A **barrier camera** like the one in Super Mario Bros would not provide a **complete view** of what is around the player and would cause **frustration to the player due to its rapid movement, distracting the player from projectiles, traps and enemy attacks**.

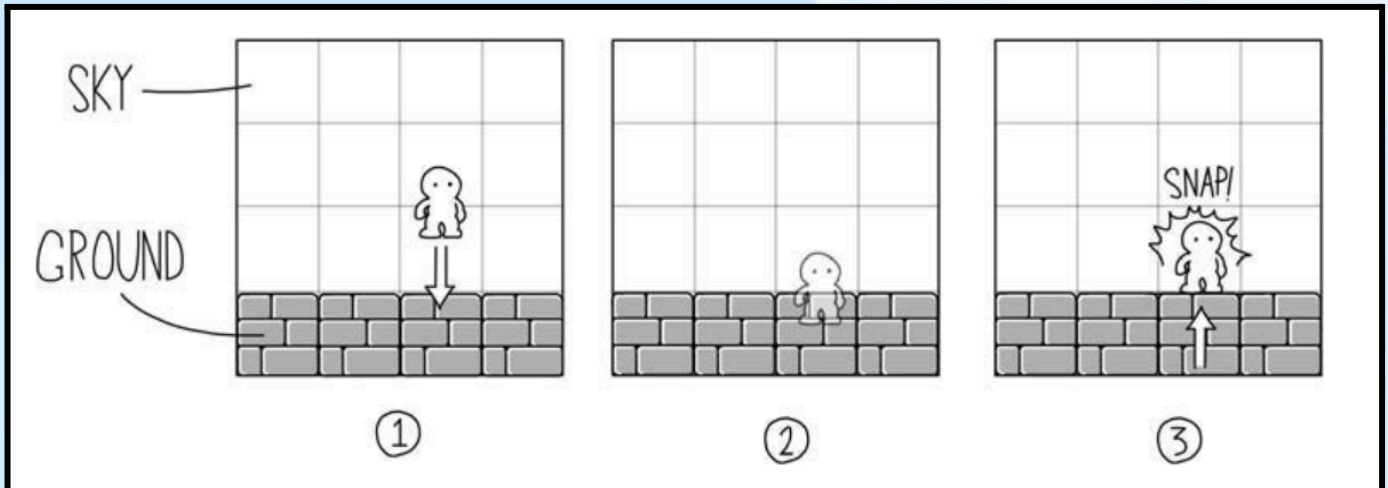
Mario's camera has **two lateral thresholds** in which Mario moves and two triggers beyond which the camera **resets almost instantly** (<10 frames) on the character. To favor the dash, this system is **replaced with a camera scroll** which can increase and evolve the challenge based on the **Level Design context**.



Frame Collision Detection

During the course of the dash **Mario remains invulnerable**, being able to **pass enemies** (but not obstacles). Collision detection varies in this case, having to manage the **Win/Fail condition** in the event that Mario **ends the dash with the sprite overlapping that of an enemy** (this inflicts damage on the protagonist). Dash movement is **interrupted if Mario collides with a non-moving obstacle**.

To overcome this problem, a **sprite snapping out system** has been added which **resets Mario's position in the event of collisions** and manages related damage events. It is always possible to **collect coins** or **1UP Mushroom** during the dash.



Execution Timing

The **execution time influences the evolution of the challenge** by adjusting the player's mastery level to **overcome specific execution patterns in order to progress in the gameplay**. The dash is reset when Mario touches a **walkable surface**, also using the slight speed boost received from killing an enemy to **create new methods of progression**.

The possibility of taking damage at the end of the dash significantly increases the difficulty of prediction and timing (mental skills) and depends on the structure of the level itself.



Level Design Context

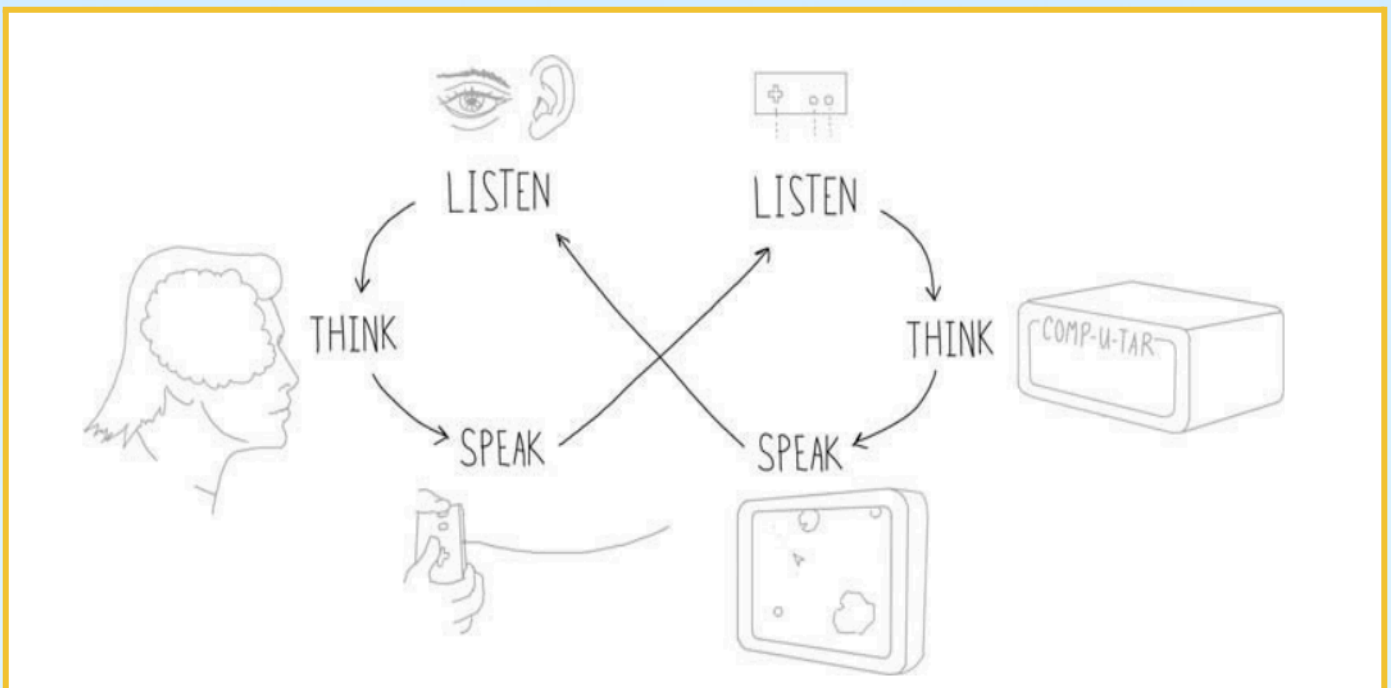
The Level Design context defines the **frequency and precision of the actions that the player performs**. As for the dash, the elements can either **block Mario's movement** (causing a Fail condition) or **inflict damage** on him causing the level to restart.

Furthermore, in underwater levels or at other specific moments the game modifies the atomic parameters of the Dash in that specific context.

Win & Fail Conditions

The Win and Fail conditions for Dash in Super Mario Bros are defined by **Boolean values that establish the outcome of the action carried out by the player**:

- **Horizontal speed**: if the player can move horizontally, then the outcome of the dash is positive.
- **Player death**: if after completing the dash the player hits an enemy or an obstacle that causes the loss of a life, the outcome is negative.
- **Reaching a point**: if the final position of the character is increased in the X direction (forward vector of the sprite) than the starting position of the dash, then the outcome is positive.



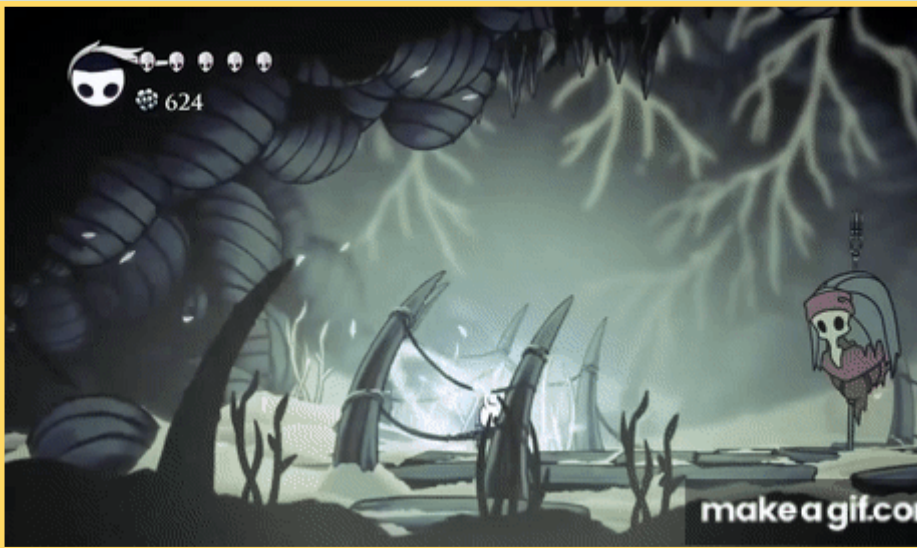
Physical / Mental / Social Skills

(Same as [Movement: Challenge Definition](#) and [Jump: Challenge Definition Skill paragraph](#), I also reported it here to keep the reasoning developed for the development of weights and values always visible in all documents regarding the definitions of the challenges)

The numerical definition of the difficulty of the overall skill of the dash consists of a **weighted mathematical average of the values of the physical, mental and social skills** required of the player to carry out the challenge. The **weights and values for the analysis are arbitrarily established** after establishing value scales with the relative meanings from which to extract the final data.

What does the player have to do?

The player uses the dash to **progress through the level**, reach a point faster, make more use of aerial movement, reach a platform or to dodge enemy attacks and kill them.



Equation Definition

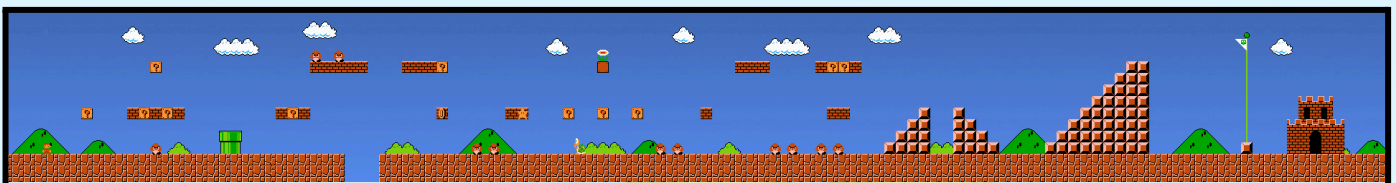
$$\text{Difficulty} = \frac{PW(P) + MW(M) + SW(S)}{3}$$

Where:

$$P = \frac{\sum_1^n (P \text{ Interaction Value})}{n} \quad \left| \quad M = \frac{\sum_1^n (M \text{ Interaction Value})}{n} \quad \left| \quad S = \frac{\sum_1^n (S \text{ Interaction Value})}{n}$$

are the arithmetic averages of the difficulty values of each skill type (**P**: Physical, **M**: Mental, **S**: Social)
The calculated average is weighted based on the weights assigned to each skill type (**PW, MW, SW**).

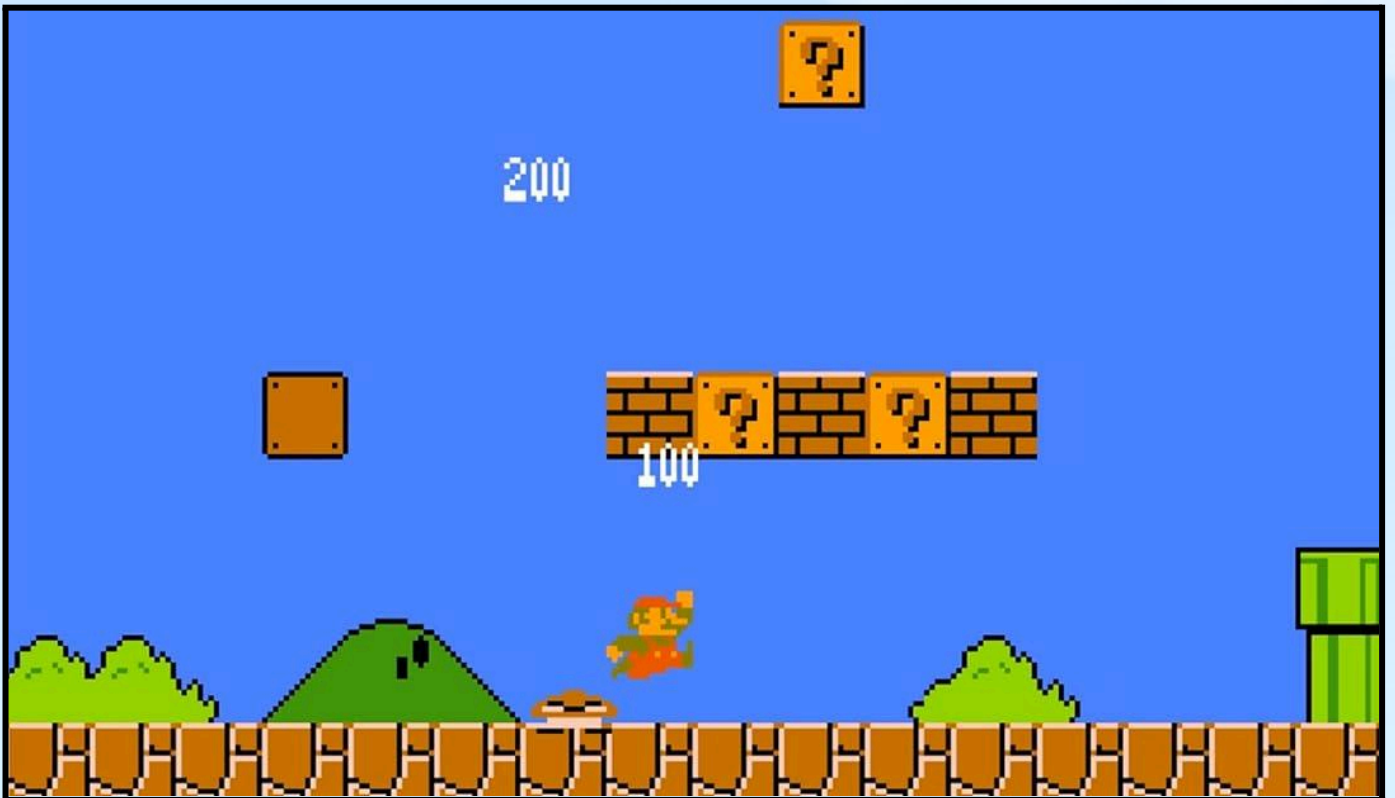
In order to have a **mathematically coherent analysis**, the objective is to give the categories weights whose **sum is equal to 1**. This premise allows the values to be **scaled correctly** and to have data that represent a **percentage of impact of the skills in evaluating the difficulty of mechanics**. The calculated average is weighted based on the weights assigned to each skill type.



Skill types weights Scale

To define the weights and values of the different types of Skills, the **number of interactions** that the player must perform which concern that category and their **frequency** are taken into consideration. The definition criteria are listed below and examples of assignment for the values are shown:

Weight Value	Number of interactions	Interactions Frequency
0	0	Low/Zero
0.25	<2	Low
0.5	<4	Medium
0.75	<6	High
1	>=7	Very High



Physical Skills

Single interaction difficulty value

The difficulty values for individual physical interactions are established based on the dash made by the player to carry out the challenge and the duration of the interaction. The difficulty is **directly proportional to the quantity of movements and inversely proportional to the duration**, the more movements the player makes the more the difficulty increases. On the other hand, the slower the interaction (longer duration) the more the difficulty decreases.

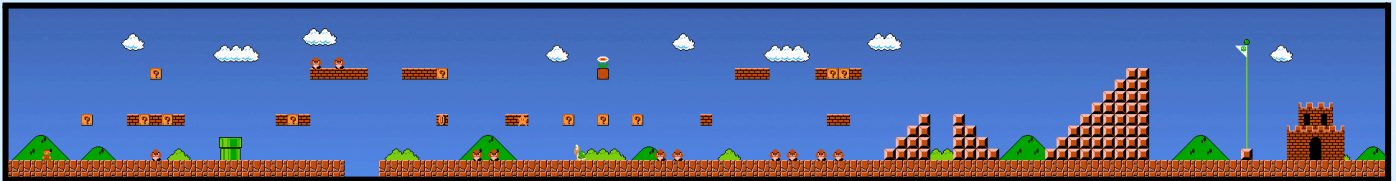
Difficulty Value	Interaction Movements	Interaction Duration Time
1	0	High
2	1	Medium
3	>1	Low

Skill Difficulty final value

Physical skills are those required to **perform the dash** through the pressure of the input. The interactions that are performed in this category are:

Skill	Description	Difficulty Value
Button Precision	The player must press the right/left button correctly. The dash is combined with the movement and/or the jump system (2 or 3 buttons are required, 1 guaranteed movement)	3
Pressed and Release Time	The player must press the button for the correct duration in order to move Mario to the desired final position	3
Timing	The player must press the button at the right time to avoid losing lives, reach a platform or hit enemies	2
Reflex	The player must have ready reflexes to respond to a danger/trap at the right time	3

$$P = \frac{\sum_1^n (P \text{ Interaction Value})}{n} = \frac{3 + 3 + 2 + 3}{4} = 2.75$$

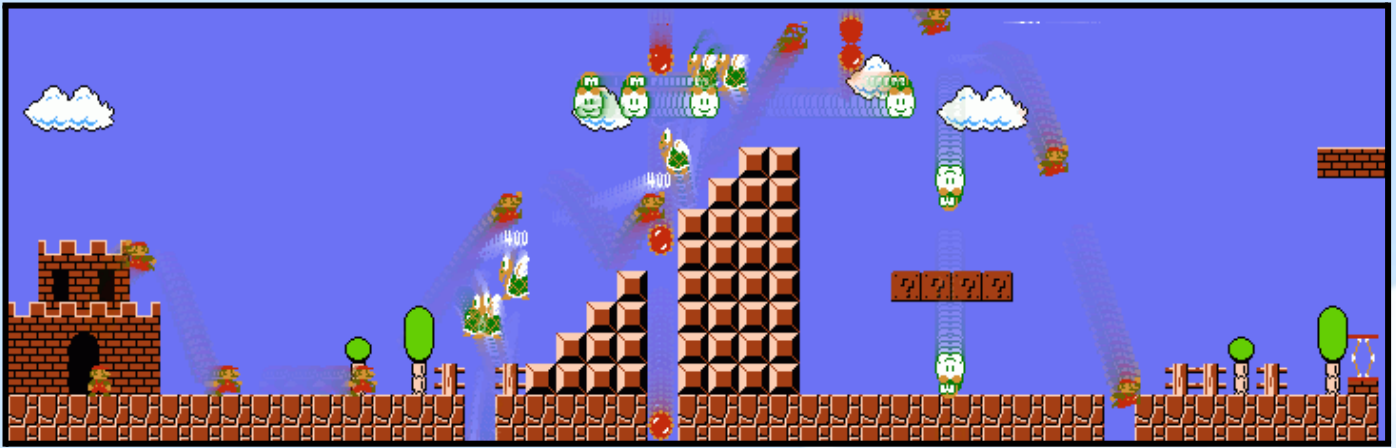


Mental Skills

Mental skills present calculation, observation and reasoning challenges for the player. Their values vary depending on the **type of pattern the player executes in order to overcome obstacles**. The dash requires more calculation regarding the **prediction and timing given by the calculation frame for collisions** and the variable distance based on the pressure of the button.

Skill	Description	Difficulty Value
Calculation	The player must calculate the distance to travel to overcome the obstacle or to hit an enemy at the right time	8
Predict	The player must predict enemies actions or platform movement/position to overcome them	8
Global Vision	The player must observe everything that is shown on the screen to think about the sequence of jumps to make to progress through the level	7

$$M = \frac{\sum_1^n (M \text{ Interaction Value})}{n} = \frac{8 + 8 + 7}{3} = 7,66$$



Social Skills

There are no social skills for movement mechanics. It is a basic game interaction and is used for purely systemic purposes, allowing the player to progress within the game world or to reach a greater score.

Movement: Final Skill Difficulty

Before calculating the final value of the Difficulty of the Super Mario Bros Dash system, the weights must be assigned to the different types of Skills.

Skill Types Weights		
Physical Skills	Mental Skills	Social Skills
0.3	0.7	0

$$Difficulty = \frac{PW(P) + MW(M) + SW(S)}{3} = \frac{0.3(2.75) + 0.7(7.66) + 0(0)}{3} = 2.07 \approx 2$$

