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Cover art: Thompson/Thomson, from *The Adventures of Tintin*. Figure from the article by Le Moëne (this issue).

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The Blood on Our Controllers: how the game industry relates to the Israeli-Palestinian conflict

Interview with Hippolyte Caubet

As we all know, this conflict began on October 7, 2023, when Hamas-led armed groups launched a surprise attack on Israel, killing over a thousand people and taking many hostages. In response, Israel initiated one of the most destructive campaigns in modern history. [1–4] This campaign escalated into genocide, resulting in the deaths of over 46,000 Palestinians, including civilians of all ages, and the destruction of more than 65% of Gaza's infrastructure. [5–9] The conflict has further intensified over the past year, with Israeli invasions extending into Lebanon and Syria.

While Western governments, media, and even the video game industry were quick to condemn Putin and Russia for the invasion of Ukraine in 2022, their responses to the genocide in Gaza have been notably underwhelming. [10–12]

The silence of the gaming industry, in particular, has drawn criticism, especially from members of the *Future Class* program, an initiative by The Game Awards designed to "represent the bright, bold, and inclusive future of video games." [10–14] In an open letter, Future Class members stated, "silence is a message. Silence is tacit support. Silence is the dehumanization of Palestinian lives." [11] They urged The Game Awards to show support for Palestinian human rights during their December 7, 2024, cere-

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mony and called on the gaming industry to address the systemic dehumanization and vilification of Muslims, Arabs, and people from Southwest Asia and North Africa in video games. [11] Despite these appeals, The Game Awards remained silent. [13]

Amid that silence, a remarkable and courageous documentary titled *The Blood on Our Controllers* was released. [12] Recognizing the meaningful intersection of geek culture, politics, and human rights, we felt compelled to highlight this documentary, so we interviewed its director, Hippolyte Caubet. Below, you will find our questions (expressing our concerns and also our stance) and Hippolyte's heartfelt answers. Through this dialogue, we hope to amplify his message and bring it to wider audiences and communities.

When we think about the war in Gaza and how the world is responding (or not) to it, the video game industry is not the first thing that comes to mind. What inspired you to create this documentary? Was there a particular event that sparked the idea for this project?

Games have been a passion for me since I can remember. Board games, role playing games and later, video games. They are incredibly powerful tools to convey feelings, emotions, and ideals. But they are not perfect, far from it. The way they have been portraying Arab communities in the past decades is alarming.

After the events of October 7th, I realised along with many people the oddly loud silence of the Western community toward the Palestinian struggle. That realisation, besides the fact that the industry **has** a role in the dehumanisation of Arab **and** stood up for other causes in the past, made it clear for me that people needed to realise that responsibility.

The documentary tries to light a spark, to make people realise the wrongs of the industry so that we may not repeat our errors and so that we try to help those who need it.

By watching *The Blood on Our Controllers*, it's clear that speaking out against the Palestinian genocide is considered risky in the game industry, with people fearing repercussions like ostracism, job loss, or loss of funding. This makes your initiative even more important and awe-inspiring. How difficult was it for you personally to start this project? Did you face any push-back or challenges during the production of the documentary?

I'm lucky to be working in a very progressive studio, so I didn't really have to fear anything for my current job. My bosses knew I was working on this project and never tried to slow down my work. Regarding future collaborations, if this project is not to the liking of some others, then they're probably people I wouldn't have wanted to collaborate with in the first place. My values are and will always be more important than my salary.

One of your interviewees mentioned expecting the game industry to respond to the war in Gaza similarly to how it responded to Black Lives Matter and the invasion of Ukraine – but it didn't. There are various reasons (e.g., racial, financial, political) that outsiders can speculate about. What are your thoughts, as an insider, on why the industry failed so miserably to stand against the genocide?

I think we failed as humans, not necessarily as the video game industry. The lack of support from the Western world after the events of October 7th could be seen everywhere.

The main reason is the normalisation of those conflicts. "War happens", "war has to happen", and "it has to happen there". We are so used to seeing those regions of the world under conflict, under the bombs, it doesn't mean anything for us anymore. All my life what I've heard of Gaza was the war, but never things about the food they eat there, the beach, the culture, or anything!

Ukraine felt like an anomaly for a lot of people. A disastrous event that we could help stop. Gaza felt like a natural disaster. But this is obviously not true, our silence and lack of empathy is only going to let this fire grow even stronger.

I focused on the video game industry because it is the people and the industry that I know; that I'm a part of. I know the part we are responsible for in the culture industry, and I also believe we can do better.

Following up on that, how hard was it to find people to interview for *The Blood on Our Controllers*? How did you select the individuals featured in the documentary?

A lot of the interviewees were contacted by Younès Rabii, who helped me a lot to produce this documentary. They were all very happy to help! I'm glad that they did.

Representation and respect for other cultures are central themes in *The Blood on Our Controllers*. You and your interviewees discussed games such as *Liyla and the Shadows of War*, *Bury Me, My Love*, and *Assassin's Creed Mirage*, though such examples are still few and far between. Are there other games you think capture this spirit? How do you see the game industry moving forward to improve representation and treat non-Western cultures with respect?

Unfortunately, there are not a lot of games like those ones. There are some, Younès tried to find one for each day of the Ramadan a few years back, but they stopped before the end as they couldn't find enough.

What we are fighting for are "testimony games" games made, designed, and published by people associated with the story. Not empathy simulators made by white people for white people. In my opinion, the best you can do to represent non-Western culture as a white Western person is to… not do it? Our culture is already so rich with themes and stories to tell! We mustn't steal the place of those willing to tell their own stories, for only them will tell them correctly.

In the documentary, you mention a passage from a war game where American soldiers cheer when a civilian building collapses after being hit by a missile. You explained that, at first, this seemed "just normal" to you and only later did you realize how horrible and absurd it was. Undoubtedly, there are similar moments in other games that many gamers might not even notice because these things have been normalized. How did you come to realize this? Do you have any advice for gamers on paying closer attention to such things?

It is always good to look at things with a deeper eye.

In the age where a lot of media or art pieces are spoon-fed so that people can "get" the message behind them without really having to think, we really need to start to "think" again. Why was this scene made? Is it trying to tell me something? What is it trying to say? What is the context? Who made this? All those questions might be relevant and at worst, give you a deeper appreciation of the amount of work that went into that scene.

I loved playing *Citizen Sleeper*, but it is because I tried to understand what the game tried to tell me that I began to grasp the philosophical intricacies of the game and that it became one of my favourite games ever. It is also through that reflection lens that I realised that most of the games I played as a young man were feeding me war propaganda ideals.

Looking at how things evolve in this industry, games are not going to change very soon regarding those points. But the way we look at them can change quickly. We might not change in a heartbeat the omnipresence of war in games, but we can already change how they affect us.

Are there any particular moments or stories that you feel are central to understanding the documentary's message?

Rami, Rasheed, and Younès's interviews are for me the most important ones. We need to listen to them to realise the work we need to do for their communities to start being rightfully recognised.

"The most this industry will do for us is improve the physics of our ragdolls when you blow us up", said Rami. That sentence sums up so much of what I'm trying to say with this documentary.

There is another sequence that I found terrifying to edit. At some point, I do a comparison between the representation of war in *Call of Duty* and IRL footage from Gaza. The images put side to side are shockingly similar, to the extent where I switched them while editing and didn't realise for a while. That realisation, that even me while editing could mistake them for one another, was bloodcurdling.

As of this interview, it has only been a few weeks since the documentary was released. How has the audience reacted to it so far? Have there been any surprising (positive or negative) or particularly moving responses?

The reception has been overwhelming. I only got nice messages and congratulations for the documentary; a lot of people seem to relate to the stories being told in it. It feels very good! This was **by far** the hardest project I ever worked on, and I worked on *Beyond Good and Evil 2* for a couple of years.

A lot of people shared the message and it sparked discussion among many people, AAA and indies alike. I'm very proud of it.

I hope to spread the word even further, so that many discussions start everywhere. My goal is not to grow big numbers or to get famous, I couldn't care less; what I want is for this documentary to have people think and discuss with their peers, colleagues, bosses, and so on.

You end *The Blood on Our Controllers* with a call to action, suggesting that games can be entertainment but also a force for good. Let's try to end this interview on a similar high note. We already mentioned some games discussed in the documentary, but there are several others out there, like *Through the Darkest of Times*, which is a personal favourite. Do you have any other inspiring games to recommend to our readers?

I am concerned by all the social impact of games. Racism, validism, sexism, antisemitism, orientalism etc.

In that sense, any game that at least tries to bring good ideals and to fight against the fascist or intolerant doxa is a great game! My most recent personal favourites would be *Neva* for its poetic approach to pollution and disease, *Citizen Sleeper* and *Hades 2* for their wonderfully diverse characters, *Venba* and *Mouthwashing* for the deep and dark themes they explore, and so many others!

Games have a tremendous power for positive change. They can help foster greater appreciation of cultures. I love games for that. They taught me so much about the world, they gave me so many great memories, so let's continue to create meaningful experiences that are respectful of others, visually striking, narratively captivating and... fun to play!

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About the interviewee

Hippolyte Caubet is a game designer and game developer at Nerial, one of Devolver's Digital studios. He started his video game journey as a young child, exploring Hyrule along many other worlds, in which his passion for games grew stronger and stronger. After a long time making small games in his bedroom, he began to work on *Beyond Good and Evil 2* at Ubisoft Paris before joining Nerial and working on *The Crush House*. Alongside his day job, he is a member of Game Impact, a French non-profit organisation fighting for a brighter, more inclusive, and respectful video game industry. He is also a great Falco main in SSBU and any person trying to deny that will be brought to justice.

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Searching for individuality: personality and behaviour of Thompson and Thomson

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Hergé's *Tintin* comic books are a classic of graphic literature that needs no introduction. Among his most charismatic characters are the detectives Thomson and Thompson (Dupont and Dupond in the original), or Thom(p)sons. The policemen with their timeless dress style and almost identical appearance are present in the majority of Tintin's adventures. They first appeared in *Cigars of the Pharaoh* (1932–1934) under the name X33 and X33A (X33 bis in the original), then were renamed "Thomson and Thompson" in *King Ottokar's Sceptre* (1938–1939). It is only in *The Crab with the Golden Claw* (1940–1941) that they are differentiated for the first time: Thompson is the policeman with the straight moustache, and Thomson the one with the curved moustache. In creating the detectives, Hergé was inspired by his own father Alexis Rémi and his twin brother, Léon, who liked to underline their physical resemblance by wearing similar clothing and accessories (Sadoul, 1989).

All along *The Adventures of Tintin*, the Thom(p)sons serve a humorous role, and are characterized by their clumsiness, both gestural and verbal. They also represent a satire of the police or public authorities (Delpérée, 2014), leading absurd reasoning and failing to make logical deductions or to keep information secret. While they regularly suspect innocent people, they also blindly believe real criminals.

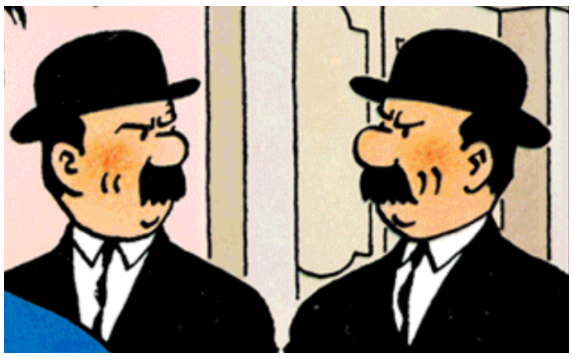

Figure 1. Thompson and Thomson (Dupond and Dupont). Image extracted from *The Castafiore Emerald* (p.58, D1).

Despite their thorough presence in the books, few elements of the Thom(p)sons' lives are known. They are familiar with each other, they address each other informally, have known each other for at least 7 years (*The Black Island*, p.37, C3) and refer several times to their "home" (*The Secret of the Unicorn*, p.2, A4, and p.32, B3), suggesting that they live together. They work for "Scotland Yard [la Sûreté]" (*The Black Island*, p.2, B3), although they are occasionally recruited by Interpol (*Red Sea Sharks*, p.9, C5). No information is known about their family, which, to many tintinophiles, echoes Hergé's unknown paternal grandfather (Peeters, 2006). Indeed, the theme of identity, or rather its ambiguity, is very present in *The Adventures of Tintin* (Bidaud, 2017). For example, various criminals usurp

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and exchange identities: the dishonest twin brother of Professor Alembick, Rastapopoulos disguised as Marquis Di Gorgonzola, a fake Prof. Calculus fooling Prof. Topolino. Some characters only have a partial identity due to their lack of first or last name, while Captain Haddock leads a mythical quest after his ancestor (and lookalike!) the Chevalier de Hadoque. When studying the Thom(p)sons, the theme of identity and that of lack of filiation is pivotal; for the simple reason that they look like twins, while having different surnames, thus they cannot be siblings. The question of the origin and kinship of the Thom(p)sons has been troubling *Tintin* readers since very early on, somewhat overshadowing that of their differentiation. Indeed, the Thom(p)sons are identical apart from their moustaches, but what about their personality? Based on the study of the Thom(p)sons' speech corpus and their actions across *The Adventures of Tintin*, this article proposes to quantify their differences in order to finally elucidate the respective identity of Thompson and Thomson.

METHODS

Book selection

The data presented in this article are based on 17 out of the 24 *Adventures of Tintin*. The last book, unfinished, *Tintin and Alph-Art* is not accounted for. In *Tintin in the Land of the Soviets*, *Tintin in the Congo*, *Tintin in America*, *The Shooting Star*, *Tintin in Tibet*, and *Flight 714 to Sydney*, the Thom(p)sons either do not appear, or do not say or do anything significant. These books are therefore excluded from the analysis.

Many changes have been made to the books throughout the reissues. This study is based on book reissues published between 2006 and 2007, which are referenced at the end of the article (Hergé, 1930, 1931, 1932, 1934, 1936, 1937, 1938, 1939, 1941, 1942, 1943, 1945, 1948, 1949, 1950, 1953, 1954, 1956, 1958, 1960, 1963, 1968, 1976, 1986). When a specific comic book box is mentioned, it is referred to by the page number where it is found, the letter corresponding to the strip it is in (from top to bottom) and the number of the box in the strip (from left to right). For example, the Thom(p)sons are introduced to king Muskar XII in *King Ottokar's Sceptre* in page 42, strip B, box 1 (p.42, B1).

Importantly, the results presented here are based on the analysis of the French version of the comics, which is Tintin's original language. Therefore, it is likely that, should this analysis be re-conducted based on the English translation, results would slightly differ.

Data collection and categorisation

A statement is defined as a speech bubble, in a box. The statement is associated with its emitter, Thompson or Thomson, on the basis of the shape of the speaker's moustache, and with an interlocutor. The order in which the Thom(p)sons speak within a box is also noted.

Bubbles containing only punctuation marks are omitted from the analysis, and so are those whose emitter is not identifiable or physically distinct. This latter case corresponds to 79 statements. The final corpus contains 928 statements, which differs slightly from the corpus established by Meyer (2007), which contains 1001 statement from an identifiable emitter.

The text corpus of each Thom(p)son is composed of all his statements. The occurrences of the famous expression "je dirais même plus" translated to "I would even say more" or "to be precise" (TBP) are counted. The quantification of lapses, or slips of the tongue, is based on the analysis by Meyer (2007). Recurring interlocutors are defined as characters who are spoken to by both Thom(p)sons, at least once.

Comedy

The Thom(p)sons are famous for their clumsiness and the comedy effect it induces. These acts are categorised as either: falls (drawn or suggested, ex: falling off the stairs), clumsiness causing benign pain (ex: collision with a pole); and other situations that ridicule the Thom(p)sons (ex: inappropriate disguise in a foreign country).

All acts are quantified per Thom(p)son and per book. When gags were spun over multiple boxes, they were counted as a single occurrence. Finally, when one Thom(p)son causes harm to the other through clumsiness, the gag is attributed to him, and not to the injured Thom(p)son.

Laterality

Object handling was annotated for each Thom(p)son to record the hand used and the object grasped, in order to determine laterality and preferred tasks. Cases in which the Thom(p)sons were not distinguishable were excluded. When an object is hung on a Thom(p)son's arm (e.g., cane or coat), but not grasped, or when an object is grasped with both hands, those occurrences are also excluded from the analysis.

Objects used less than 20 times in total are grouped into categories: papers (arrest warrant, newspapers, books, letters, envelopes, telegrams), packages (parcels, packages, boxes), drinks (glass, beer), and social (handshakes and other social contacts, including with Snowy). A category "tools and accessories" included: boats, pockets, stair ramp, ropes, cars, sticks, jerricans, banknotes, lighters, pills, car hoods, cigarettes, keys, cushions, nets, fans, binoculars, magnifying glasses, coats, blackjacks, handcuffs, watches, umbrellas, shovels, pendulums, coins, door handles, wallets, skeletons, tobacco, test tubes, pipes, and suitcases.

It should be noted that this quantification should be considered with caution, since the scoring was done per box. For this reason, when the same object is present on several pages in a row, it is counted many times, artificially increasing the use of the hand holding it. However, many inversions are also present in-between the boxes, justifying this method of quantification.

Statistical analysis

For each measured parameter, the percentage attributable to each Thom(p)son is calculated per book. In case of complete absence of the parameter in a book, a value of 0 was attributed to each Thom(p)son. The percentages shown in the results are the mean of the percentages calculated by book, by Thom(p)son.

The raw data of the number of speech bubbles, of bubbles read first, of interlocutors, of initiated dialogues, of comic acts, percentage of hand usage and frequency of speech disturbances, were analysed with Wilcoxon tests for non-parametric data. The distribution of recurring interlocutors between the Thom(p)sons is tested with a Fisher's test, and the distribution of comic acts and object handled with the χ^2 (chi-squared) test.

The figures and analyses were obtained with RStudio 2024.09.0 and R 4.4.1 (*tidyverse* package). The Thom(p)sons' speeches were analysed with word cloud with the help of iramuteq version 0.7 alpha2 (30 UCE, core French dictionary).

Statistical significance threshold is set at 5% (p-value < 0.05). A trend is defined by p-value < 0.10.

RESULTS

Speech distribution

During the *Adventures of Tintin*, the Thom(p)sons emitted 928 speech bubbles whose emitter was unambiguously identifiable. Of these, 405 belonged to Thompson, and 523 to Thomson. On average across the

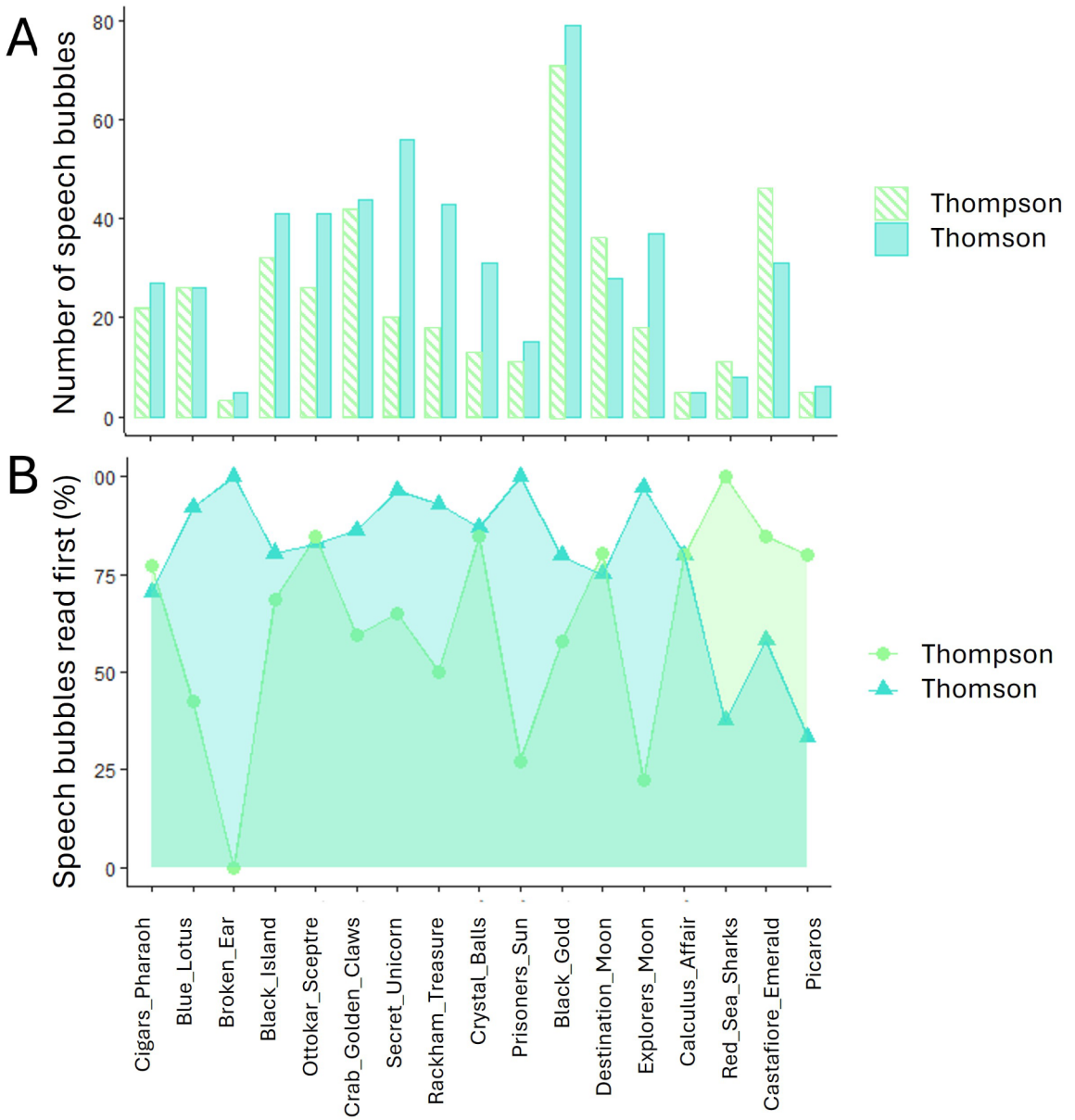

Figure 2. Speech bubbles distribution for Thompson (green) and Thomson (blue). **A.** Number of speech bubbles per Thom(p)son and per book. **B.** Percentage of bubbles read first, for each Thom(p)son, with respect to the total number of speech bubbles of the character.

Tintin books, Thompson expressed 43.58% of the bubbles, and Thomson 56.41%. The preponderance of Thomson's speech over Thompson's is statistically significant (Wilcoxon test, V = 98, p = 0.033). Thompson speaks more often than Thomson in only 3 of the 17 albums, starting from *Destination Moon* (Fig. 2A).

Bubbles formulated by Thompson are read first either when he is the only one speaking in a box, or when he speaks before Thomson, which corresponds to 62.63 ± 6.49 % of his text corpus. For Thomson, the proportion of bubbles that are read first is higher (79.41 ± 4.84 %). Across the 17 books analysed here, bubbles read first belong significantly more often to Thomson (V = 113.5, p = 0.020), even though this effect fades, or even disappear from *Destination Moon* (Fig. 2B).

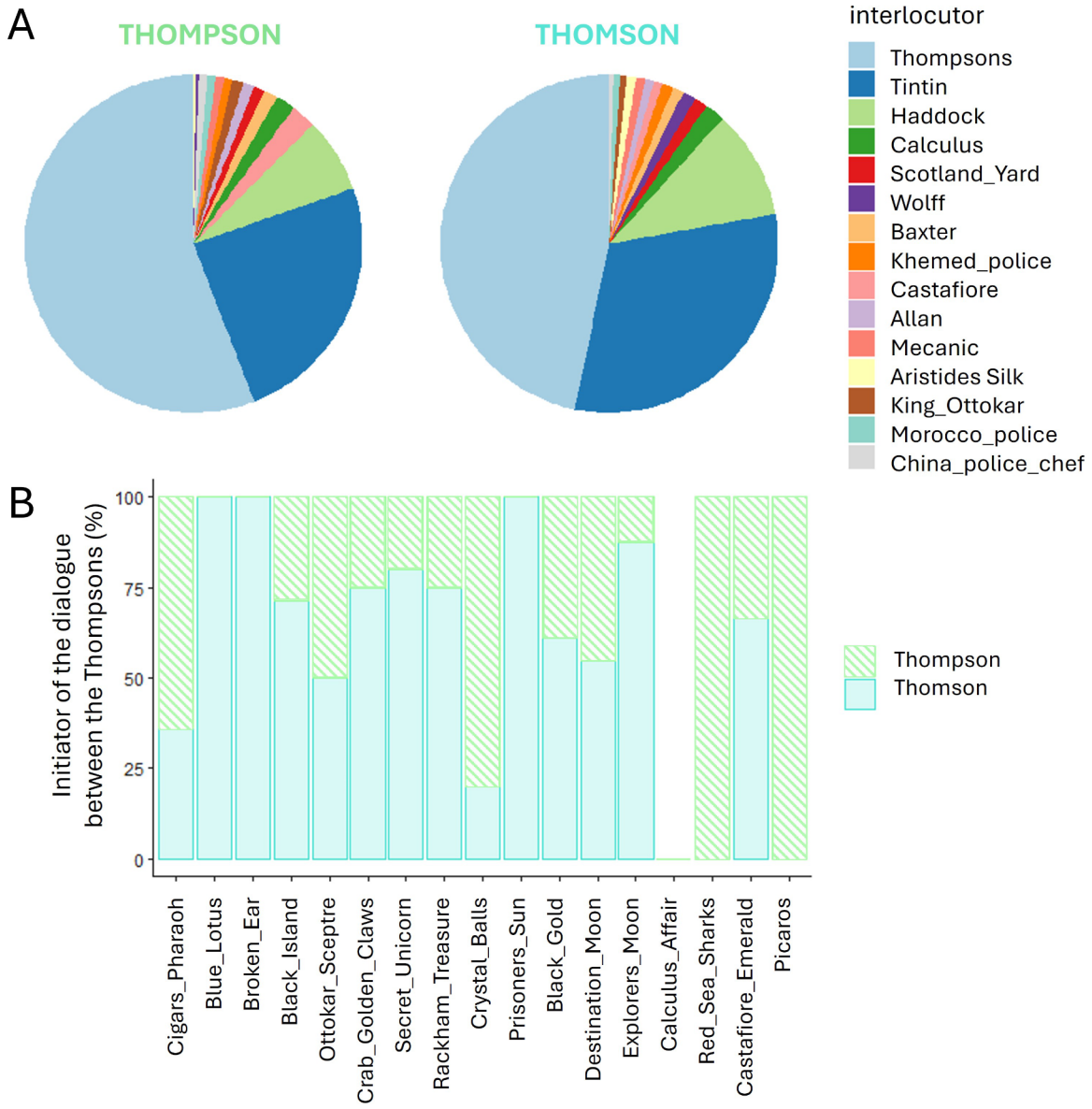

Figure 3. A. Proportion of speech bubbles directed to the 15 recurring interlocutors of the Thom(p)sons. **B.** Percentage of inter-Thom(p)sons dialogues initiated by Thompson (green) and Thomson (blue).

Interlocutors

In the 17 *Tintin* books in which the Thom(p)sons are significantly present, there are 55 different interlocutors, 34 for Thompson and 49 for Thomson, including 28 in common. The main interlocutor of each Thom(p)son is the other Thom(p)son, with 428 bubbles (46.12 %) of the total corpus directed towards one of the Thom(p)sons.

The number of interlocutors per book is similar for both Thom(p)sons, although there is a slight tendency towards a larger number of interlocutors for Thomson (V = 12.5, $p = 0.072$). Indeed, on average over the albums, Thomson talks to 89.78% of the total number of interlocutors, and Thompson to 76.36%.

Fifteen recurring interlocutors were identified, the most frequent besides the Thom(p)sons being Tintin, Captain Had-

dock, and Professor Calculus. Speech is addressed to these recurring interlocutors uniformly, regardless of the speaking Thom(p)son (Fisher's Exact Test, $p = 0.203$) (Fig. 3A).

Inter- Thom(p)sons dialogues are characterized by a stronger initiation by Thomson. Thomson is the initiator of the exchange and Thompson the respondent in 62.22% of the dialogues (Fig. 3B). This initiation rate biased in favour of Thomson does not, however, reach statistical significance ($V = 27$, $p = 0.064$). Notably, Thompson initiates 100% of the dialogues in *Red Sea Sharks* and *Tintin and the Picaros*.

Bubbles content

Thompson and Thomson are well known for their characteristic elements of language, in particular the repetition of the expression "I would say even more"/"to be precise", or the frequency of their slips of the tongue and other speech disturbances. During the *Adventures of Tintin*, Thompson utters the expression "to be precise" (hereinafter TBP) 38 times, and Thomson only 20 times. Across the 17 books, Thompson tends to use this expression more often ($V = 32.5$, $p = 0.065$). On the other hand, slips of the tongue are made by both Thom(p)sons at the same frequency ($V = 31$, $p = 0.758$). The data taken from Meyer's article (2007) show that Thompson is responsible for 32.22 ± 9.76% of slips of the tongue during the albums, and Thomson for 38.37 ± 10.33%.

The representation of the text corpus of each Thom(p)son by word cloud highlights a smaller lexicon for Thompson, and the high frequency of the expression TBP (Fig. 4A). For both Thom(p)sons, the most frequent interlocutors "captain_Haddock" and "reporter_Tintin" were represented, as well as several verbs characteristic of their detective work: "aller" [go], "voir" [see], "trouver" [find], or "regarder" [look] (Fig. 4).

Comedy

The legendary clumsiness of the Thom(p)sons contributes to the recurring situational comedy that accompanies their

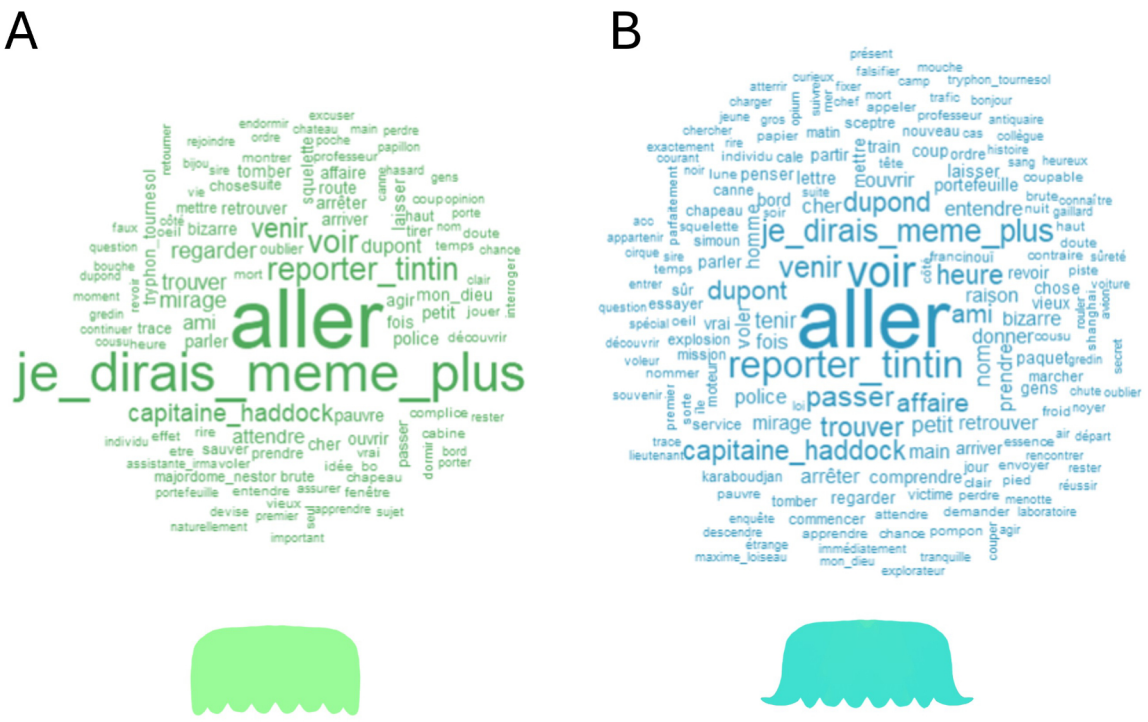

Figure 4. Word clouds (in French) from the respective text corpuses of A. Thompson, and B. Thomson.

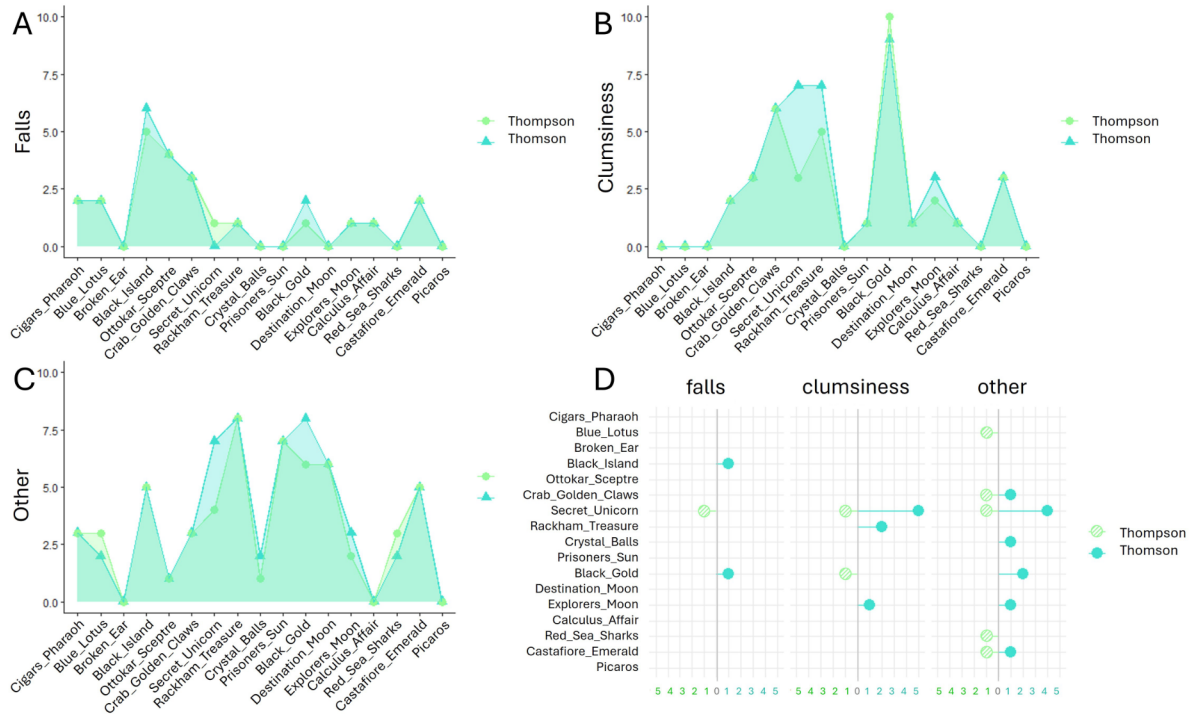

Figure 5. Occurrences of situation comedy due to the Thom(p)sons' **A.** falls, **B.** clumsiness, **C.** other gags. **D.** Occurrences specific to one of the Thom(p)sons.

interventions. The vast majority of the comic episodes are common to both Thom(p)sons: the fall of one is followed by the fall of the other. This is visible in the distribution of comic actions between them: Thompson accumulates 23 falls, 37 clumsy acts, and 57 other gags. Thomson makes 24 falls, 43 clumsy acts, and 62 other comic actions ($\chi^2 = 0.096$, $p = 0.953$) (Fig. 5). Despite this similarity, a slight trend emerges over the books towards a greater number of comic acts attributed to Thomson ($V = 31$, $p = 0.075$). This trend is particularly visible when looking at the distribution of non-common comic actions, which are more often due to Thomson (Fig. 5D).

Laterality

Throughout the *Adventures of Tintin*, the Thom(p)sons handle 67 different objects or people. Firearms are systematically held with the right hand for both Thom(p)sons, and so are pens. In addition, only Thompson drives (in *Land of Black Gold* and in *The Calculus Affair*).

To handle the most frequently used objects, both Thom(p)sons mainly use their right hand (Fig. 6A). The most frequently grasped object is their cane (395 times for Thompson, 476 times for Thomson). By comparison, the second most characteristic object of the Thom(p)sons, their hat, is grasped only 41 and 34 times by Thompson and Thompson, respectively. The different types of objects are handled by both Thom(p)sons uniformly ($\chi^2 = 7.159$, $p = 0.413$).

In the books, we observe that to grasp their cane, Thompson uses his left hand more often than Thomson (in 49.04% vs 40.20% of the cases respectively; $V = 83$, $p = 0.060$) (Fig. 6B). However, when combining all objects (excluding canes, firearms, and pens), no difference in lateralization appears between the Thom(p)sons ($V = 21.5$, $p = 0.328$) (Fig. 6C).

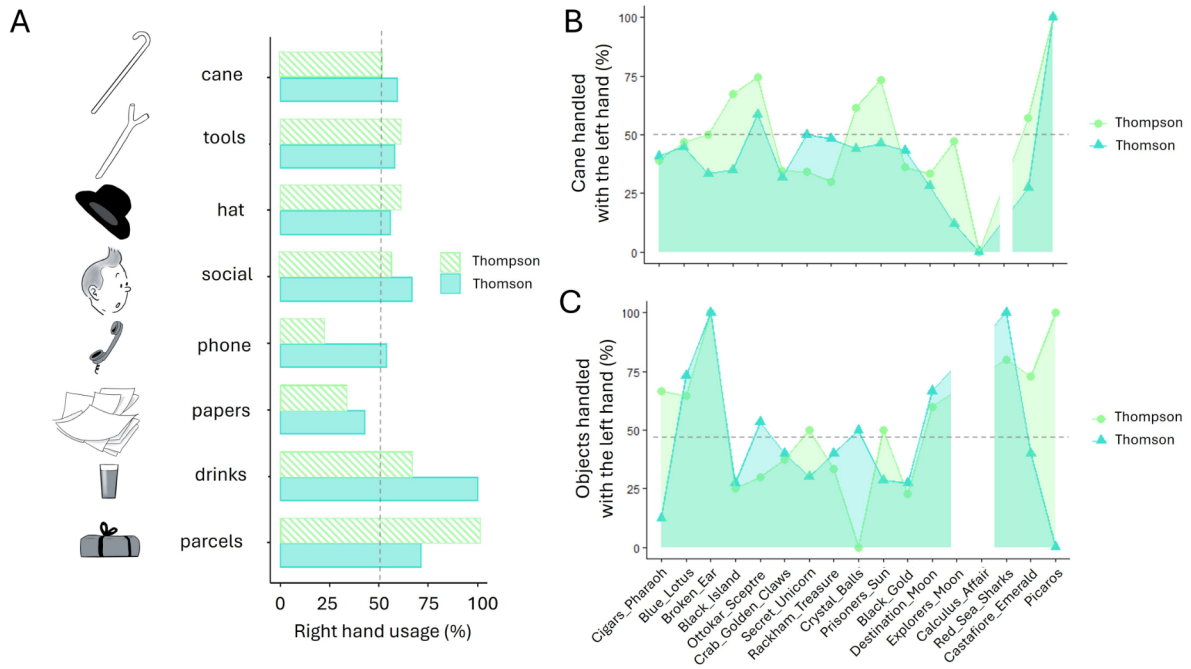

Figure 6. Laterality of Thompson (green) and Thomson (blue). **A.** Usage of the right hand to handle the most frequently used objects, all *Tintin* books pooled. **B.** Cane handling with the left hand (%) throughout the *Adventures of Tintin*. **C.** General left-hand usage (%) (all objects pooled, excluding canes, pens, and firearms).

Individual profiles of the Thom(p)sons

The parameters analysed above capture key elements of the personality and behaviour of each of the Thom(p)sons. The average percentage of each parameter, for each Thom(p)son, is represented in a radar profile in Figure 7.

DISCUSSION

The Adventures of Tintin have been the subject of a plethora of analyses by tintinophiles and tintinologists. However, within the body of work discussing the characters of *Tintin*, Thompson and Thomson have been the subject of (too) little consideration. Although several books have dealt with the Thom(p)sons, within tintinophiliac (Groensteen, 2006) or medical studies (Bonnemain, 2005; Castillo, 2011; Bidaud, 2017), very few have dealt with the Thom(p)sons specifically, at the exception of the excellent *Le Dupondt sans Peine* (Algoud, 1997). Therefore, this paper is, to the author's knowledge, the first one investigating the quantifiable difference in personality between Thompson and Thomson.

In the present study, the word clouds from each Thom(p)son's corpus highlight the similar role of the Thom(p)sons in *The Adventures of Tintin*, namely their relative passivity in the investigation, with the preponderance of the verbs "come", "see", "go", "look", "find", and "leave". Rather than actively investigating, the Thom(p)sons make an "act of presence". Regarding the laterality of the Thompsons, rumours have circulated suggesting that one was right-handed and the other left-handed. On the contrary, the data collected here show that both Thom(p)sons are right-handed, they only use their right hand for aiming and writing, and still use it preferentially to manipulate most objects.

It is the analysis of the text corpus and the actions of the Thom(p)sons that clearly shows their difference: Thomson appears more extroverted; he talks more, frequently takes the initiative, has more interlocutors, and commits more unique comic actions. On the contrary, Thompson is more with-

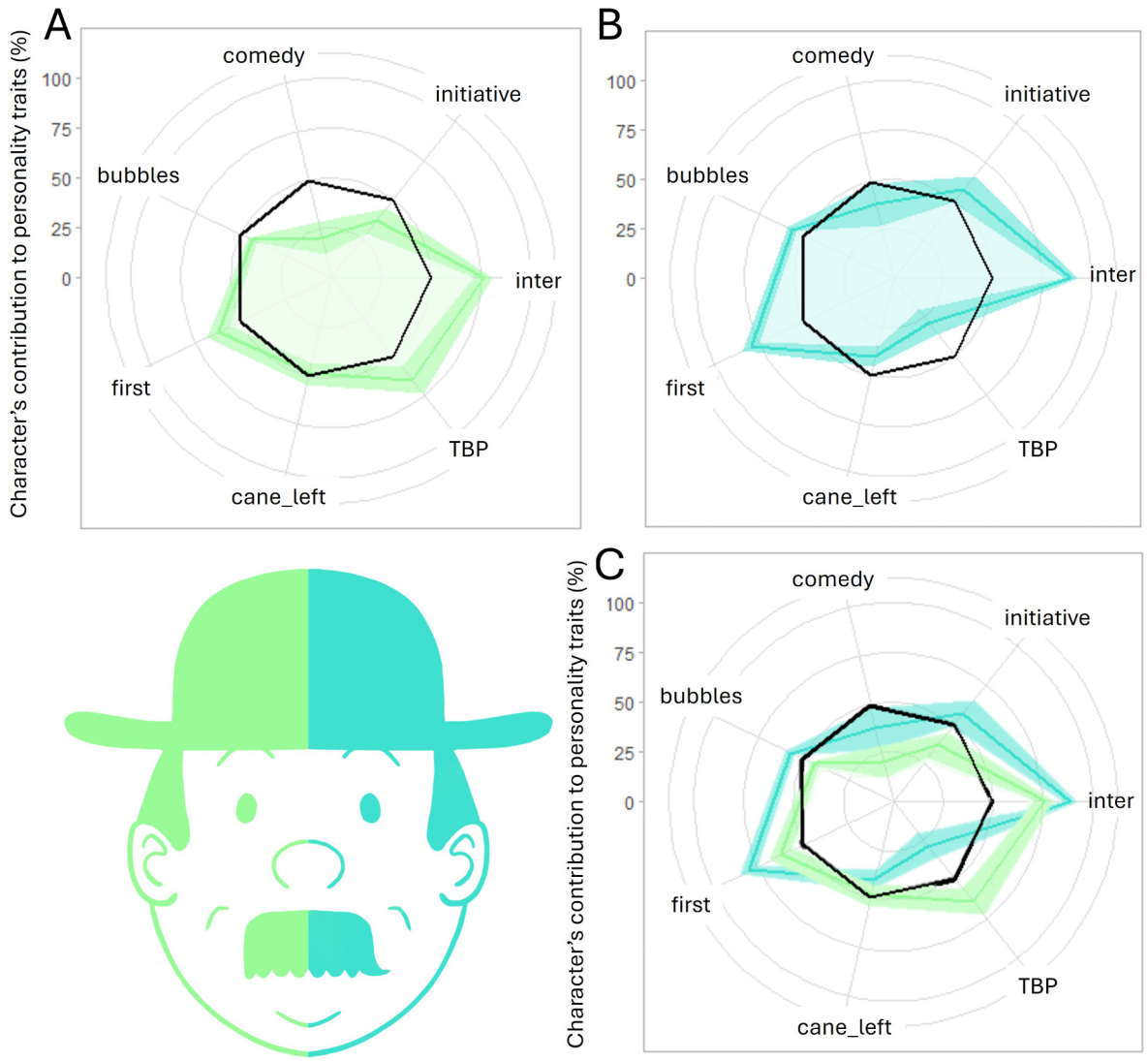

Figure 7. Radar profiles of **A.** Thompson, and **B.** Thomson. **C.** Overlaying of the profiles for comparison. The profiles represent 7 parameters of the Thom(p)sons' personality, measured from their text corpus and their actions in the *Tintin* books. Values are expressed as mean percentage of the parameter (over 17 albums) ± standard error of the mean. The black heptagon represents the 50% threshold, if each Thom(p)son contributed exactly half of the total observed. The parameters are abbreviated as follows: comedy = occurrences of unique comic acts; initiative = initiation rate of the inter-Thom(p)sons dialogues; inter = interlocutors; TBP = occurrence of "to be precise"; cane_left = cane-handling with the left hand; first = speech bubbles read first; bubbles = number of speech bubbles.

drawn, often serving as a support to Thomson, responding to and emphasizing his statements, notably through the expression "to be precise". Finally, even though poorly, only Thompson drives, and he seems to handle his cane with ambidexterity.

It is interesting to note that these trends, confirmed in almost all the books, are reversed in the last *Tintin* books, starting with *Destination Moon* (1956). Thompson then seems more extroverted than Thomson. This inversion in their personality could be deliberate on Hergé's part, supposedly out of concern for fairness between the Thom(p)sons or out of weariness with their usual dynamic. At the same time, it is precisely in the last *Tintin* books that we originally find inversions in the Thom(p)sons' names. These errors were acknowledged by Hergé and corrected in the reissues. We initially find inversions in *Destination Moon* (p.24, B3), *Red Sea Sharks* (p.7, D2), *The*

Castafiore Emerald (p.58, D1), or *Tintin and the Picaros* (p.60, A2). This list (potentially not exhaustive, due to the author's difficult access to the original editions) suggests that the reversal of the Thom(p)sons' role in the books is effectively accompanied by a confusion in their names by Hergé.

The role of the Thom(p)sons in *The Adventures of Tintin* is often limited to their humorous scope, or to the highlight of Tintin's impressive skills. However, even if this is rare, the Thom(p)sons also make the investigations progress, when their police master key allows doors to be opened (*Cigars of the Pharaoh*, p.57, D1) or when they partially elucidate the theft of Ottokar's sceptre (p.43, A2–B1). While the lucidity of their reasoning in *King Ottokar's Sceptre* surprises the readers, they themselves judge this case to be "childishly simple" (p.42–43). On the one hand, Tintin is logical, capable of quick deductions and of influencing geopolitical decisions (*Land of Black Gold*, p.35–36), but has a forever juvenile physique. On the other hand, the Thom(p)sons have a stark physique, marked with age with a partial baldness under their hats. Unlike Tintin, the Thom(p)sons act immaturely despite their age.

The recurring characters of *Tintin* form together "the Moulinsart family": an adopted family, rebuilt by characters without history or family ties (Bidaud, 2016). In this context, one can wonder about the role of the Thom(p)sons within this family. Vexed by yet another recommendation from Tintin in *The Castafiore Emerald* (a recommendation that they will obviously fail to follow), they exclaim "We are not children anymore!" (p.39, D3). And yet… they systematically address each other informally, which is different from all the other adult characters in Tintin (in French), and we see them sleeping in the same room in *Prisoners of the Sun* (p.10, A3–C3), just as children would. Terribly naive and displaying a somewhat lacking general culture, their credulity and their multiple episodes of clumsiness (a glorious total of 246 comic incidents over the course of the 17 books analysed here) reinforce their childish side. They are scolded by Tintin for their bickering about bedding in *Red Rackham's Treasure* (p.16, D1) who asks them "Aren't you ashamed, at your age?". Earlier, in the same book, Professor Calculus is surprised by their clumsiness which he interprets as "childishness" (p.8, B2). Finally, their statement "We have had moustaches since our early childhood!" in *Tintin and the Picaros* (p.47, C1) suggests either that they have changed very little since childhood, or even that they have not emerged from it yet.

The ambiguous identity of the Thom(p)sons contributes to their infantilization. It appears that the individual personality of each Thom(p)son is not yet crystallized, since the trends are reversed over the course of the books. They themselves hesitate between fusion, through physical and behavioural resemblance, and differentiation, by emphasizing the difference in their surnames and their unequal verbal interactions (Bidaud, 2017). The fact that Hergé himself confused them in some strips raises a smile: the Thom(p)sons are reminiscent of twins playing on their resemblance, to the point of successfully misleading their own parent.

Laterality scoring highlights two representations of the Thom(p)sons: either as doubles or as mirror symmetries. Once again, the Thom(p)sons appear to be prisoners of their status, either as the same or the reverse of the other, they can only exist by comparison to each other. A previous analysis of the Thom(p)sons' text corpus suggests that their co-existence hides a rivalry: the incorrect repetitions of the other's speech actually serves as a mechanism of self-affirmation (Meyer, 2007). The data reported here suggest that Thomson is the most present in the books, while Thompson strives to exist alongside him, by repeating what he says, or through emancipation by driving.

Finally, the Thom(p)sons become physically indistinguishable on two occasions: at the end of the *Land of Black Gold* due to the ingestion of N14 which mutates their hair system, and during a relapse in *Explorers on the Moon*. Thus, despite their extreme phys-

ical resemblance and similarity in behaviour, it is the disease that makes them indistinguishable. We could therefore conclude that a healthy Thom(p)son is a unique Thom(p)son.

CONCLUSION

The data collected for this article allow us to distinguish a general trend between the personality of the Thom(p)sons, with a more withdrawn Thompson and a more extroverted Thomson. Several elements of the *Tintin* books infantilize the Thom(p)sons. It could suggest that they have not yet reached maturity, and still maintain a fluid and ambiguous identity. One thing is certain: Thompson and Thomson are eternal and still have plenty of time to grow up.

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Supplementary File

Translation of the present article to French.

Acknowledgements

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About the author

Dr Olivia Le Moëne is an ethologist and researcher in behavioural neuroscience. She is an (avid) graphic novel enthusiast and a (slight) data analysis geek. Fascinated by universes of fiction, she enjoys looking at artistic creations under the light of the scientific method.

Journal of Geek Studies

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Botany Manor: a cozy game unveiling the inequalities in academia

Interview with Laure De Mey and Kitt Byrne

Botany Manor is a multiplatform game developed by the English indie studio Balloon Studios and published by Whitethorn Games. Initially released in April 2024, the game was well received by both gamers and critics.

Set in a 19th-century British manor, *Botany Manor* puts you in the role of Arabella Greene, a retired botanist researching plants for her book 'Forgotten Flora'. The game revolves around investigation and puzzle-solving, allowing Arabella to grow plants from seeds and gain a deeper understanding of their biology. While all the plants in the game are fantastical, they draw inspiration from nature, making botanical elements a central theme. As you progress, you'll also uncover Arabella's past, her scientific career, and her experiences navigating the male-dominated world of academia.

A game infused with science and academia? That certainly piqued our interest. After completing *Botany Manor* (and loving it – we should disclose that bias here), we reached out to the team behind the game with some burning questions. In the end, we scored a double interview with creative director and programmer Laure De Mey and game designer and 2D artist Kitt Byrne.

You'll find their answers below, marked with their respective initials (LDM and KB).

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Please note that the interview contains spoilers for *Botany Manor*, so we recommend finishing the game before reading further.

What inspired you to create *Botany Manor*? Was there a particular event, book, or figure in the field of botany that sparked the idea for this game?

LDM: I first came up with the idea for the game when visiting a stately home in England. There are so many games set in manor houses that have a horror or fighting theme, and I realised that I would like to play a game where the player gets to explore a place like that in a relaxing way. I was also very inspired growing up playing the *Tomb Raider* games, and specifically Lara Croft's manor.

The botany theme came about more organically as I was developing the idea further. A visit to Down House – the home of Charles Darwin – really furthered my idea of a dedicated individual who would use every corner of their home to further their research.

Someone I was particularly inspired by is Marianne North, and her extensive body of botanical paintings, which I was able to enjoy during a visit to Kew Gardens. In researching her, I discovered more about how much women have contributed to the science of botany and how at certain times in the past they have been excluded from academia, along with working class or amateur scientists.

In the game, players can cultivate various types of plants with specific needs, ranging from somewhat normal to fantastical. Did you draw inspiration from real-world plants for the in-game content? If so, which ones?

LDM: Yes, although there is a fantastical element to the game (plants don't generally grow instantly!). I felt passionate about always referencing a real life, natural example as inspiration for the plants in the game. For example, the Ash Plume, which needed fire to germinate the seed and a specific smoke to encourage blooming, is based on pyrophyte plants like the Pine Lily.

KB: The Pixie Tears, which requires glucose rich soil to grow due to its lack of chlorophyll, bears a resemblance to Ghost Plant (*Monotropa uniflora*). The Springdance Shrub responds to rhythmic music or vibrations nearby, and this was inspired by the theory that beeswing vibrations can cause a response in a plant during pollination. There are of course more inspirations for the other plants but we'll let players discover and research those for themselves.

LDM: We also wanted to include plants that might be considered weeds, because as lovers of nature we care about rewilding and treat nature as a whole, beautiful ecosystem, instead of only selectively growing attractive plants.

Is there a particular plant in the game that is a favourite or that you are especially proud of?

KB: I keep changing my mind but my current favourite is the Nightfall. To create the visual concept, I looked at night time flowering plants, so the leaf shape is inspired by the Fishbone Cactus (*Disocactus anguliger*). I also love the lore in the game surrounding this plant.

LDM: My personal favourite plant is the Sapphire Gloom, a misunderstood mushroom that grows on trees. It was inspired by the Hazel Glove, a fungus that typically grows on hazel trees and consumes the

harmful Glue Crust fungus from their bark. From a visual point I also really love the blue colours of the Sapphire Gloom!

What kind of research went into developing the game's botanical elements and in creating its "Victorian naturalist" setting?

LDM: We undertook all sorts of research during the development of the game. This included visits to historic houses to observe the furnishings, equipment, and surface patterns, as well as lots of book-based research to learn about the history of botany and what life would have been like for our protagonist, Arabella.

KB: We created a timeline including the key developments in botany, and how this would have influenced Arabella and also her grandmother who taught Arabella botany as a child. Historic books and articles provided illuminating sources including John Lindley's statements about excluding women from botany in order for it to be taken seriously as a scientific pursuit. We found *Flora Domestica* by Elizabeth Kent, and learned about how she initially had to publish her work anonymously.

Throughout the game, we find letters that tell us more about the protagonist Arabella and her world. Such items are commonly used by games to achieve this, but in Botany Manor, it is a perfect fit. Correspondence between naturalists was very common, with Darwin's letters being a prime example in Biology. Did you read through some published letters to get ideas for the game?

KB: Yes, this was one of the most valuable resources we had for developing the narrative in the game. In particular, the letters and writings of Maria Jacson that we discovered in the immensely helpful book: *Cultivating Women, Cultivating Science, Flora's Daughters and Botany in England, 1760-1860*, by Ann Shteir.

Although not specific to botany, we also found the letters of Dr Agnes Bennett to her female colleagues and students at the Edinburgh Medical College for Women in the 1890s to be of great value. The supportive tone these women employed during such a challenging time for women in the field was a great inspiration.

***Botany Manor* captures very well many aspects of academia, from research and discovery to more unsavoury ones that we will get to later. Did anyone on the team have previous experience working in academia?**

KB: I had a very brief moment working at a museum but other than that, no. However, we discovered many parallels to some of the hurdles that certain people face working in the games industry. We also reached out to friends and family who do work in present-day academia to gather their experiences and input on this theme.

LDM: I also have not worked directly in academia, but having a computer science background and working in the games industry definitely gave me some experiences and challenges to look back upon for inspiration.

Returning to the in-game correspondence, we learn that Arabella participated in scientific expeditions and fieldwork, but her knowledge and achievements were not recognized, except by a few close collaborators. This mirrors the reality faced by women in academia back then – a famous example being British naturalist (and coolest palaeontologist ever) Mary Anning. Inequalities and lack of recognition for women (and minority groups) still plague academia today. The representation of this reality in the game is spot on, which is why we asked about past experiences in academia. How did you manage to tell this story so well?

LDM: I think we can credit this to a combination of factors: the sources we found during our research, and our own experiences working in an industry that doesn't do as well as it should in removing barriers to particular people from less advantageous backgrounds.

KB: When developing the narrative, we recorded all of the examples of discrimination or lack of recognition that we gathered from research, friends and our own experiences. From there we edited down to a few key moments that captured the tone and frustration of doing good work that gets overlooked for a seemingly unrelated arbitrary reason. It has been really validating to hear players empathising with that feeling when they play the game.

***Botany Manor* ends with Arabella's book not being published. As researchers, we must say that hits really close to home. Why did you choose to end the game that way?**

LDM: I knew I wanted the game to end this way right from the very beginning, because to me it was the only ending that would be true to the time. Many women's works didn't get published back then, and even to this day important works are found to be wrongly credited to someone's brother or husband. I also felt the link to Arabella's 'Forgotten Flora' would be stronger if she is, among many other women, forgotten about. On top of that, being recognised publicly is not the most important thing in life, and eventually Arabella managed to create her legacy in a different way.

KB: I was passionate about this ending when I learned during development about Olive Dame Campbell. She was a folklorist who broke tradition and attended college in 1900, then spent years collecting folk songs in Appalachia while her husband was conducting social research there. Ultimately her work was published in *English Folk Songs from the Southern Appalachians*, by Cecil Sharp and Olive D. Campbell, in 1917. However, only Cecil Sharp's name remains in contemporary discourse around folk music, an injustice that inspired the 2000 film *Songcatcher*. Olive went on to found the John C. Campbell folk school in North Carolina (named after her late husband) – a non-competitive school dedicated to improving the quality of life of local residents through crafts and traditional skills. That school still exists to this day, and it seemed like a fitting end for Arabella to also find an alternative way to bestow her passion and research to her community.

What advice would you give to aspiring game developers who want to incorporate a pinch of science into their games?

KB: Don't be afraid of doing some deep dive scientific research, and a great place to start is books written on a specific topic because they have done most of the work for you. You might be surprised at how many fans come out of the woodwork to appreciate those efforts!

LDM: I always say I am a pedantic game designer, and I try to stay as true to real-life physics as possible. That said, it's okay to bend those rules a little bit for the sake of fantasy and excitement, just try to be consistent in how you do that. In *Botany Manor* we included fantastical plants, but all the other parts of the research were very grounded and logical (if a little simplified), to foster a feeling of authenticity.

Do you have any take-home message you would like the players to get from *Botany Manor*?

KB: For me the message is about not giving up, and taking pride in your own achievements no matter how small. Even if we can't achieve some lofty ambitions, we can still make a difference to one another like Arabella does by opening her school.

LDM: I echo the above, though I also wanted to try and find a way to help people understand how it feels to be overlooked, misjudged or underestimated, so that, if they find themselves in a position to make a difference, they can make a difference and prevent that from happening to people like Arabella.

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About the interviewees

Kitt Byrne: I'm a game artist and game designer working at Balloon Studios. Previous games I've worked on include *Botany Manor* (Balloon Studios), *The Mermaid's Tongue* (SFB Games), *Gibbon: Beyond the Trees* (Broken Rules), and *Snipperclips Plus* (SFB Games). I've been part of BAFTA nominated and Apple Design Award winning game teams, and most recently was selected as a BAFTA Breakthrough for 2023. I enjoy creating art, narratives and puzzles the most in my work on games. I'm not nearly as good as Arabella at keeping plants alive but always have succulents and houseplants growing at home, with my favourite being *Oxalis triangularis*. I also have a soft spot for liverworts because they are so unusual looking and seem to be overlooked and treated as weeds most of the time. My favourite game at the moment is Flock – another science inspired game about observing and documenting fantastical creatures.

Laure De Mey: I founded Balloon Studios and most recently created and led the development team on *Botany Manor*, our debut game. Prior to this, I worked at Ustwo Games, the studio behind acclaimed titles like *Monument Valley* and *Assemble with Care*. I'm originally from Belgium, and I honed my skills as a software engineer before moving to the UK. I was named a BAFTA Breakthrough talent in 2021. My absolute favourite games tend to be very grounded and immersive, such as *Return of the Obra Dinn*, *Eastshade* and *The Forgotten City*. The game I played most recently was *Grunn*, a bit spookier than I usually would go for but I got really sucked into it anyway!

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Is a bone a viable weapon when combating a Rancor? Estimating the bite force of an intergalactic mega-predator

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In the first act of '*Star Wars: Return of the Jedi*' (ROTJ), the protagonist, Luke Skywalker, infiltrates the palace of the notorious crime lord, Jabba the Hutt, while seeking to free his allies from captivity. After a short discussion and a failed assassination attempt, Luke and an unfortunate Gamorrean, fall through a trap door triggered by Jabba and find themselves in a large dusty cavern strewn with bones. Here, a gigantic metal blast door slowly rises revealing Jabba's pet monster: a large male Rancor – a 5-meter tall, bipedal, reptilian creature (Starwars.com; Fig.1).

After grabbing and devouring the Gamorrean in a series of bites, the Rancor turns to find its next prey. In desperation, the young Jedi grabs a large (mammalian?) femur to protect himself, only to be grabbed by the Rancor and lifted towards an ignominious end as a Rancor snack. Just as the Rancor goes to bite Luke, he lodges the femur in its jaw lengthways, forcing the Rancor to drop him. Despite the Rancor having opposable digits that are capable of holding and manipulating objects, the Rancor closes its jaw, causing the femur to splinter, eventually snapping in half. This is a fantastic biomechanical feat - typically mammalian femurs have evolved to resist high levels of vertical loading, and in many terrestrial mammals, including humans, the femur is often the largest and strongest bone in the skeleton (Erickson et al., 2002).

The ability of the Rancor to snap the femur with apparent ease poses interesting questions: (1) how much dorso-lateral force is required to snap a femur of the size used by Luke to stave off the Rancor in ROTJ? (2) Could the Rancor generate such force with its jaws? Lastly, (3) could any other extinct or extant organisms generate such force?

Despite the fact that Rancor exist(ed?) a long time ago in a galaxy far, far, away, there are techniques employed in paleontological research that can answer the questions outlined above. The only direct evidence we have of ancient organisms is their fossilised remains. However, fossils are not truly representative of the organism as it was in life; after death, the processes of decay act to strip biological information from the carcass. Typically, soft tissues are lost rapidly, leaving only the 'hard' biomineralised tissues such as bones, teeth, or shells to persist long enough to become geologically stabilised as fossils (see Clements & Gabbott, 2022). However, the hard tissues are also subject to a range of destructive processes that commonly result in fragmentation and deformation of the organisms'

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Figure 1. Silhouette size comparisons of extinct, extant, and intergalactic mega-predators. a1. Adult male Rancor. a2. Adult *Tyrannosaurus rex*. a3. *Homo sapiens*, represented by Luke Skywalker, who is 1.75 m tall (a little short for a stormtrooper). a4. The largest extant terrestrial predator, the polar bear *Ursus maritimus*. b. Film still of Pateesa, a male Rancor kept by Jabba the Hutt, with a femur lodged in its maw (*Return of the Jedi*). c. Film still of a juvenile Rancor being imprinted by the bounty hunter Boba Fett (*The Book of Boba Fett*, Ch. 3: The Streets of Mos Espa). d. Film still of Boba Fett riding the juvenile Rancor during a battle with a Scorpenek droid (*The Book of Boba Fett*, Ch. 7: In the Name of Honor).

remains. These complex processes of fossilisation can make it difficult to make accurate inferences about what ancient creatures looked like and how they lived, especially if the organismal group is extinct and/or has no modern analogues for direct comparison (see Lautenschlager, 2016).

Yet despite this, palaeontologists are incredibly adept at incorporating advanced analytical methods developed in other sectors to unlock the biological information stored in stone. One common example is the use of Finite Element Analysis (FEA) in palaeontological investigations (Rayfield, 2007; Bright, 2014). Originally designed by civil engineers to simulate and predict the deformation of objects with complex geometries, palaeontologists now regularly use FEA to investigate the biomechanical properties and functional capabilities of fossilised skeletal remains - allowing unparalleled understanding of the bite force of charismatic ancient predators, such as *Tyrannosaurus rex* (Rayfield, 2004; Fig. 1a2), the sabre-tooth cat *Smilodon fatalis* (Figueirido et al., 2024), the carnivorous fossil whale *Basilosaurus isis* (Snively et al., 2015), giant pliosaurs (Foffa et al., 2014), and the so-called "terror bird" *Andalgornis steulleti* (Degrange et al., 2010).

Typically, FEA is undertaken by creating digital three-dimensional models of fossil skeletons either by computed tomography (CT) scanning, laser scanning, or photogrammetry (Cunningham et al., 2014; Sutton et al., 2014; Diez Diaz et al., 2021). Soft

tissues, such as muscles, nerves, blood vessels, etc., can be reconstructed using various techniques to create a musculoskeletal model which can then be incorporated into FEA (see Lautenschlager, 2016). In the case of the Rancor, there are no canon diagrams of the skeleton, only videos and pictures of the animal complete with soft tissues – actually the inverse situation of palaeontological investigations. However, in many palaeontological studies, fossils are not always available or accessible to be digitised, e.g., when fossil specimens are in collections in remote locations, or are too fragile to be transported, or have been destroyed/lost. In such cases, 3D models can be created from scratch in a digital environment using a so-called box-modelling approach. In this scenario, models are created from simple geometries and subsequently refined following a sketch or photograph as template (Rahman & Lautenschlager, 2016). Here, we utilise these techniques to reconstruct the cranial skeleton of the Rancor and assess its bite force ability using Finite Element Analysis.

METHODOLOGY

Rancor morphology and behaviour

Since their introduction in ROTJ, Rancor have become a commonly recurring organism in the Star Wars franchise. Native to Dathomir, a temperate planet found within the Outer Rim Territories (Fry, 2019), Rancor are described as 'reptomammals' within the Star Wars universe – reptilian organisms that have evolved mammalian traits (Whitlatch & Carrau, 2001). Rancor do not have scaly skin, rather a thick 'leathery' hide that is known to be able to resist high energy blaster fire and projectile weapons (Sansweet, 1998). Rancor are reported to be endothermic, and lay clutches of egg pairs. While Rancor have been reported to demonstrate parental care (in a similar vein to some crocodiles), they do not suckle their young – although it should be noted that it is not clear whether they can lactate (Whitlatch & Carrau, 2001). Here, we assume that Rancor are reptiles.

Rancor (and the several subspecies) are large bipedal carnivores characterised by short stocky legs and long arms that terminate in hands with four distinct digits: the first, second, and third are elongate and tipped with sharp claws, while the fourth digit is vestigial. In ROTJ, the male Rancor (named Pateesa; Bray et al. 2015; Fig. 1b) walks upright in a slow and lumbering manner. We now know this is not usual for Rancor: Pateesa is housed within a cavern with no natural light that is far too small for such a large predator. In later books, Luke Skywalker indicates that he believes that Pateesa was malnourished and abused during its captivity in Jabba's palace (Anderson & Moesta, 1995; see also Perrin, 2002). This hypothesis is supported by the appearance of a juvenile Rancor in *The Book of Boba Fett* (Ch. 7: In the Name of Honor; Fig. 1d). This individual demonstrates that Rancor have a quadrupedal gait, similar to knuckle walking used by Gorillas (although Rancor use the palm of their hand, and not their knuckles) to rapidly and nimbly negotiate complex three-dimensional terrain. Moreover, Rancor demonstrate a high level of coordination when using their long arms and opposable digits to grasp and manipulate objects, allowing them to nimbly capture fleeing prey (such as unfortunate Gamorreans) or to expertly undertake complex tasks such as dissembling battle droids (Fig.1d).

One aspect of Rancor is that the head is extremely large for their body size, yet they have strikingly flattened facial features including a pair of large nostrils inset between two small eyes, and a mouth lined with sharp teeth (often demonstrating malocclusion), however, as far as we know, there are no official canon reconstructions of the skeleton or the skull. There are two interesting Rancor facts that may impact our ability to model the cranial anatomy: 1) in ROTJ, the top of Pateesa's head inflates and deflates as it is breathing – implying that there may be some sort of dorsal skull opening that is covered by dermis. However, this is not seen in the Rancor from *The*

Book of Boba Fett and is unconfirmed. Perhaps this structure acts as a vocal sac (e.g., similar to some frogs), but this is speculative. For the purpose of this work, we will not factor in this unique cranial arrangement. 2) Despite their reputation as mindlessly vicious hyper-predators, Rancor are known to be social, emotionally complex (Fig. 1c), and sentient organisms capable of forming complex social hierarchy and being able to communicate oral traditions and histories to each other (e.g., Windham, 2007). However, determining brain-to-body mass ratios is difficult across the animal kingdom, and unlike palaeontological work using skulls, we are unable to model brain size in our reconstructions.

Reconstructing the skull of a Rancor

The skull of the Rancor was reconstructed using the ROTJ model (created by Phil Tippet) as a reference (Fig. 1b). Assuming an anatomy similar to archosaurs found on Earth (e.g. dinosaurs, crocodiles, and birds), we believe it would be likely that the skull would be similar to their life appearance without extensive facial muscles, fat pads and other soft tissues substantially obscuring the skull morphology. Further, we assumed that, as a generic reptile-like organism, the Rancor skull shows a diapsid condition (all assuming that Star Wars creatures loosely follow the known organismal classification). Diapsids possess two temporal openings (=fenestrae) at the side of the skull; in contrast to mammals and their ancestors with one temporal opening, and turtles which have no temporal openings.

In order to study the musculoskeletal morphology and function of any animal using computer simulations, a digital model of the skeleton is required. In the absence of a preserved (or drawn) skull, we reconstructed the skull using the box modelling approach (described above) to model the hypothetical skull and lower jaw of a Rancor using Blender 2.9 and 4.2 (blender.org) (Fig. 2). This model then served as the basis for the soft-tissue reconstructions and biomechanical analyses (below).

Cranial muscle reconstruction

Detailed knowledge about the size and arrangement of the jaw musculature is required to estimate bite forces accurately and to provide input forces for biomechanical simulations. The number and position of the jaw closing muscles vary between different animal groups. As the Rancor is a reptile, we reconstructed eight separate pairs of jaw closing muscles, typical of fossil and modern reptiles, such as crocodilians, birds and dinosaurs. All muscles were re-

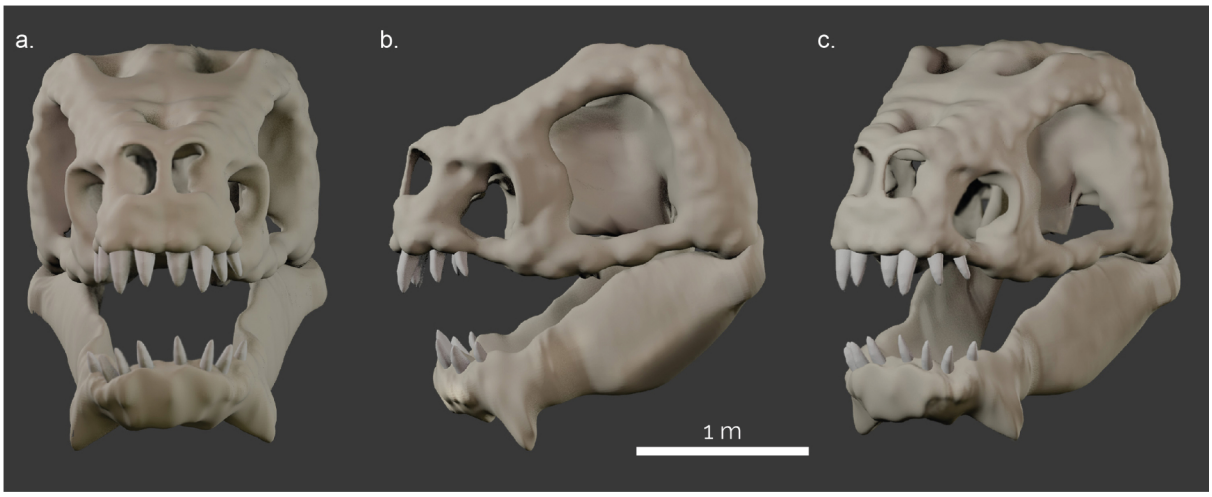

Figure 2. Digitally reconstructed skull of a Rancor in **a.** frontal, **b.** lateral, and **c.** oblique frontal view.

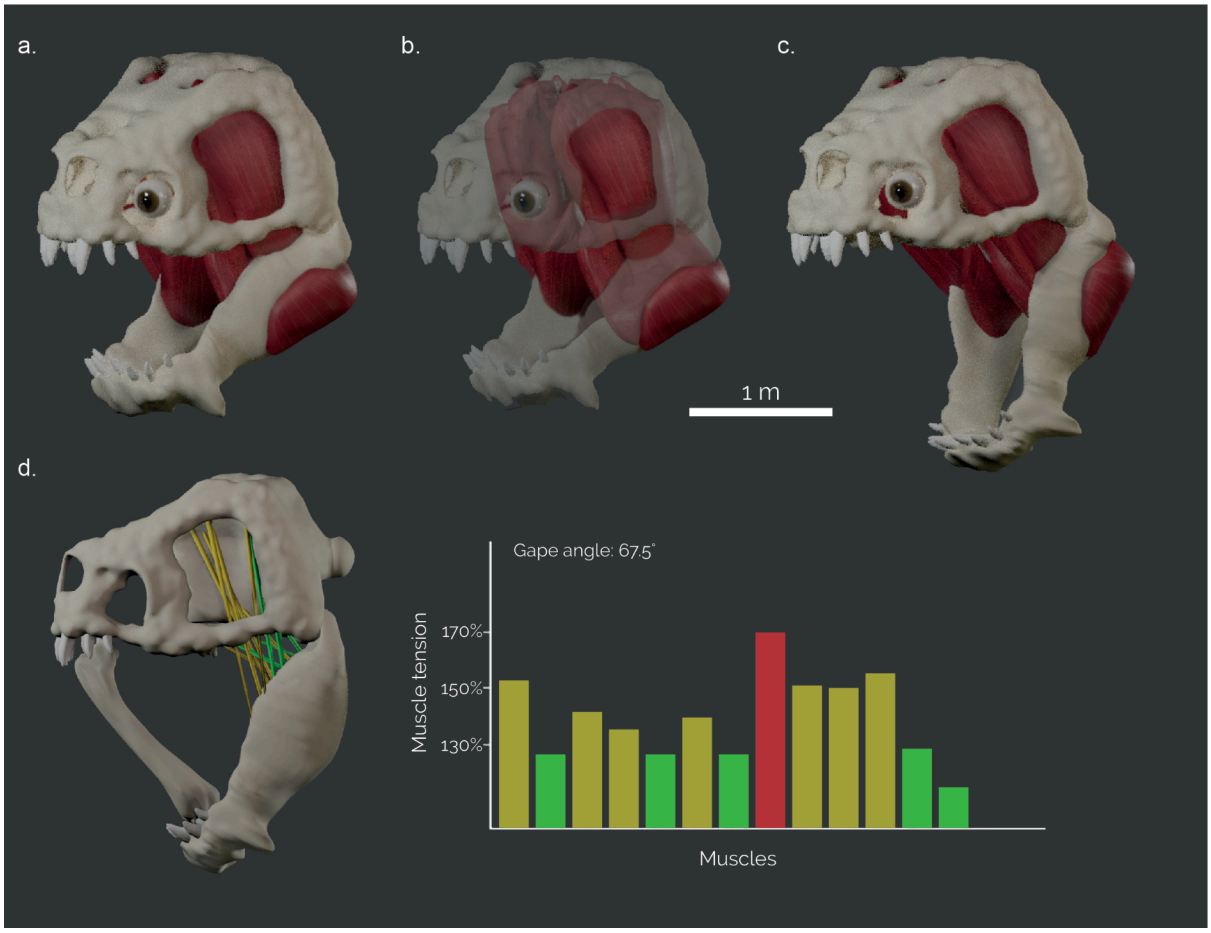

Figure 3. Digitally reconstructed jaw musculature of a Rancor with the skull rendered **a.** solid, **b.** transparent, and **c.** with maximum gape angle of 67.5 degrees. **d.** Maximum gape shown based on muscle tension analysis with bone placed within the jaws.

constructed digitally by first identifying the hypothetical attachment sites on the skull and the lower jaw (following the method outlined in Lautenschlager, 2013, 2016). Although these muscle attachments are unknown in Rancor, similar patterns are observed across different extinct and extant vertebrate groups allowing educated inferences to be made. In a next step, corresponding attachment sites were connected digitally by simple point-to-point connections. This allowed identifying intersections between muscles, or between muscles and bone, that require manual adjustment of the connections. In a final step, the simplified connections were fleshed out to create the full muscle bodies (Fig. 3a–c). These steps were performed in Blender 2.9 and 4.2.

Gape analysis

Once the muscles have been modelled, it is possible to assess the gape of the Rancor. Gape, in this context, refers to the ability of an organism to open its jaw and is measured as the angle of the lower jaw relative to its closed position. To do this, the skull and mandible models were joined at the jaw joint and the mandible was allowed full rotation around the mediolateral axis (y-axis) to simulate sagittal opening and closing. Adductor muscles were represented by cylinders connecting the attachment sites. An opening motion with a step size of 0.5° was imposed on the lower jaw, during which the muscle cylinders were stretched. For each step, the ratio between the resting length and the extended length of the muscle cylinders was calculated until any of the muscle cylinders reached the critical exten-

sion limit of 170%; a limit based on experimentally derived values above which tetanic tension of mammalian adductor muscles is no longer possible (Lautenschlager, 2015).

Biomechanical analyses

In order to evaluate the biomechanical capabilities (e.g. bite forces, stress resistance) of the Rancor, the skull model was subjected to finite element analysis (FEA). FEA is a computational engineering method that calculates the stress distribution and behaviour of objects in response to external load forces.

In preparation for the FEA, the skull and mandible models of the Rancor were imported into Hypermesh (Altair, v. 11) for solid meshing and the setting of boundary conditions. The final models consisted of ca. 700,000 elements for the skull and 450,000 elements for the mandible. The models were assigned material properties for Alligator bone (E = 15,000 MPa, v = 0.29) (Porro et al., 2011) and teeth (E = 60,400 MPa, v = 0.3) (Creech, 2004) in an approximation of likely material properties for the Rancor. In a next step, constraints were added to the jaw joint (six nodes on each side) and the occipital condyle (five nodes) to fix the model from rigid body movement. Further, one node was constrained on the second tooth in the upper jaw and the posteriormost tooth on the lower jaw to record reaction forces (=bite forces). Muscle forces were added as individual load vectors to the model to replicate muscle action.

To test the hypothesis that the bite performance of the Rancor is sufficient to break a long bone with its jaws as depicted in ROTJ, a generic model of a long bone with a length of 1.5 meters was generated. We ascertained the approximate size of the long bone used by using the height of actor Mark Hamill (Luke Skywalker) as a scale (see Fig. 1). It is important to note that the leg bone used by Skywalker is much larger than any extant mammal found on Earth today – to our knowledge the organism that yielded the bone has never been taxonomically identified in the Star Wars literature. The bone model was meshed accordingly and assigned the same material properties for mammalian bone (E = 10,000 MPa, v = 0.4) (Rayfield, 2007). It was subsequently subjected to load forces equivalent to the resultant bite forces of the Rancor model.

All models were imported into Abaqus (Simulia, v. 6.141) for analysis and post-processing. Biomechanical performance was assessed via von Mises stress contour plots and reaction forces measured at the tip of the teeth. The final FEA models consisted of ca. 750,000 elements for the skull model, ca. 500,000 elements for the lower jaw, and ca. 150,000 elements for the isolated long bone. Models were solved on a Windows PC with Intel core i7 processor, 32 GB RAM, and an Nvidia GeForce mx350 2GB graphics card. Solving times for the individual models took between 10 and 20 minutes.

RESULTS

The reconstruction of the jaw musculature allowed an estimate of the overall muscle force, yielding an overall force of 116,000 N. Due to the vertebrate jaw being a third-class lever, with the muscle force situated between the jaw joint and the bite point, the resultant bite force is typically a lot lower. Measurements from the finite element models resulted in a bite force of ca. 44,000 N for the Rancor. The digital models of the cranial skeleton and the musculature further allowed estimating the maximum gape angle based on muscle tension. Maximum achievable gape was found at an angle of 67.5˚.

The evaluation of stress distribution following a bite with maximum muscle contraction shows relatively low stresses in the skull and somewhat higher stresses in the lower jaw. In the latter, stress hotspots are found anteriorly just behind the tooth row and at the posterior region of the jaw at the muscle attachment sites. This is to be expected as the lower jaw represents an elongate beam that is subjected to bending due to the muscle and bite forces.

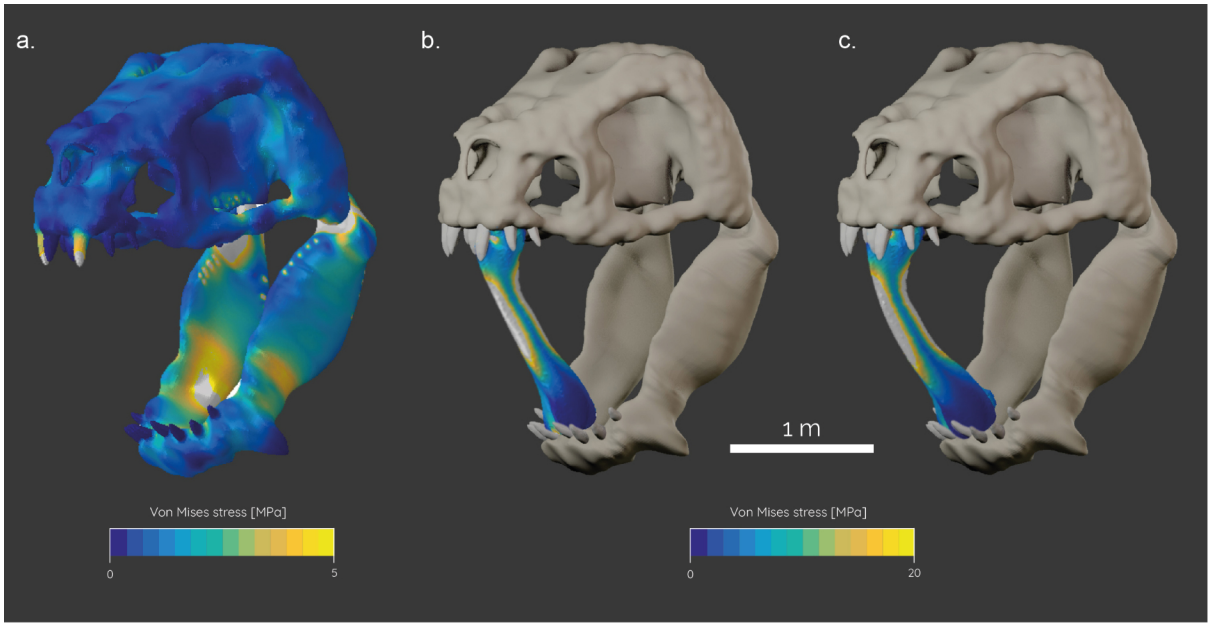

Figure 4. Results of the finite element analysis (FEA) with stress distribution shown as contour plots for **a.** the Rancor skull and **b, c.** the single long bone (length = 1.5 m). The bone in **c** is shown with induced deformation due to the stress.

The biomechanical analysis of the mammalian femur under load showed that the bone experiences high stress values (up to 200 MPa) in the midshaft region. The femur is predominantly subjected to compressive stresses due to the bite force acting at both epiphyses which consequently leads to bending of the bone. This force exceeds the bending strength for most vertebrate bones, such as Alligator femora (Currey, 1987; Erickson et al., 2002) and is within the yield limit of human long bones (Turner & Burr, 1993).

DISCUSSION

The FEA modelling (with the caveat of some major intergalactic anatomical assumptions) indicates that the Rancor's bite strength is more than capable of vertically snapping a large long bone and that the skull of the Rancor could easily tolerate such loadings. We, therefore, suggest that, in a life threatening situation, utilising a long bone to prevent the Rancor from devouring you can only be relied upon as a temporary measure – in the specific case of Luke's encounter with the Rancor, the usefulness of a long bone is likely further diminished by the desert climate of Tatooine: bones that are 'dry' are known to have a lower bending strength and are more brittle than fresh or wet bones (Curry, 1988).

How does the Rancor's bite force compare to other known organisms? Our data suggests that no living vertebrate's bite force comes close to the Rancor (Fig. 5). It is estimated that the white shark (*Carcharodon carcharias*) has the strongest bite force of an extant organism, determined to be over 18,000 N (Wroe et al., 2008). However, the highest bite force measured is from the Saltwater crocodile (*Crocodylus porosus*) exerting around 10,0000–16,000 N of pressure (Erickson et al., 2012, 2014). Iconic terrestrial mammalian predators typically have lower bite forces – the spotted hyena (*Crocuta crocuta*) has a bite force of ca. 9,000 N (Meers, 2002). The largest bear species, the polar bear (*Ursus maritimus*), can generate bite forces of around 5,000 N (Slater et al., 2010), while large cats such as the lion (*Panthera leo*) and the tiger (*Panthera tigris*) achieve bite forces of ca. 1,500–2,000 N. Surprisingly, mammalian herbivores/omni-

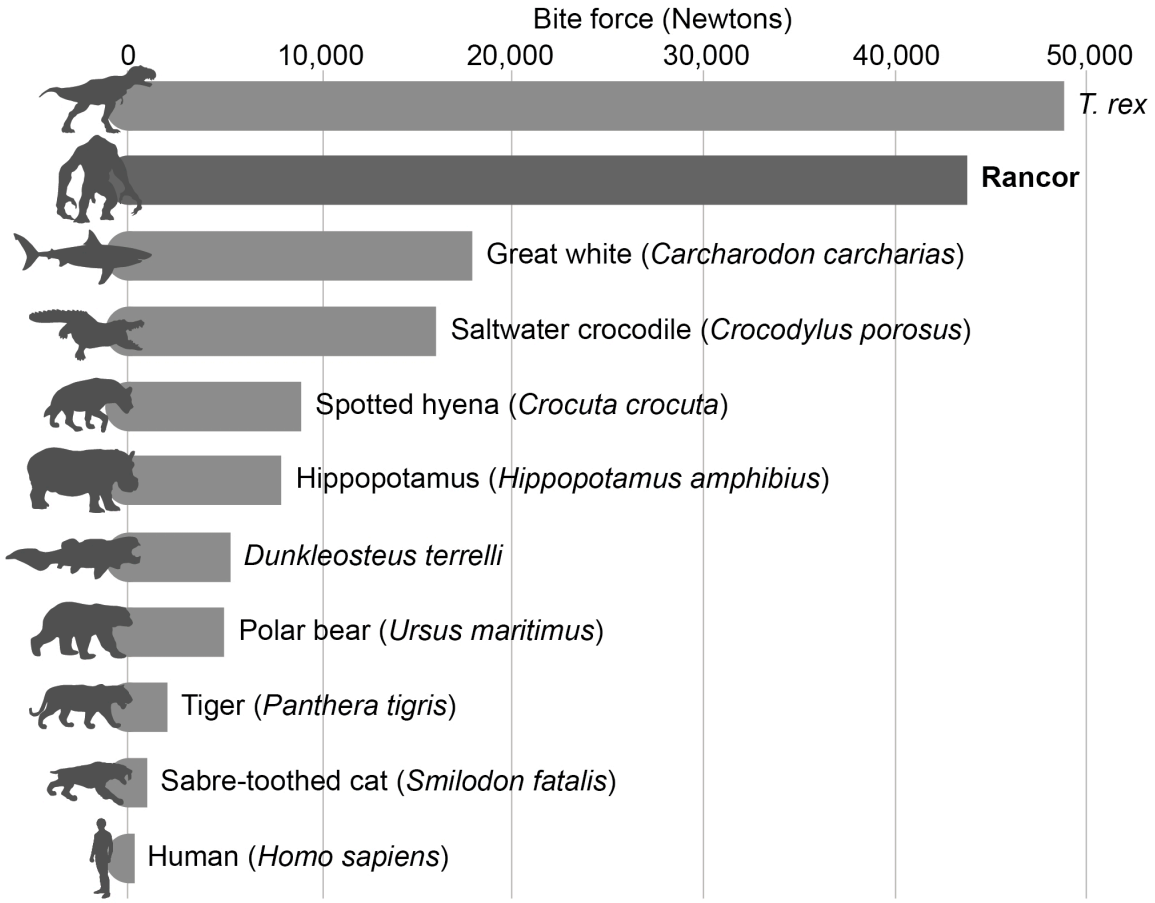

Figure 5. Bite force of extant, extinct, and intergalactic organisms (in Newtons). Organism silhouettes not to scale

vores have high documented bite forces – gorillas (*Gorilla gorilla*) can generate bite forces of ca. 5,000 N (Eng et al., 2013) while the hippopotamus (*Hippopotamus amphibius*) have bite forces of ca. 8,000 N (Haddara et al., 2020). Human beings (*Homo sapiens*) have a bite force of ca. 150–300 N during typical mastication but can reach bite forces of up to 700 N (Takaki et al., 2014).

In terms of extinct organisms, the Rancor's bite force sits amongst the charismatic predatory theropod dinosaurs. Sakamoto (2022) suggests that some mega-carnivorous theropods had a lower bite force than the Rancor; e.g., *Spinosaurus aegyptiacus* (ca. 12,000 N), *Carcharodontosaurus saharicus* (ca. 17,000 N) and *Acrocanthosaurus atokensis* (ca. 26,000 N). However, while estimates vary significantly, the proposed bite force for the iconic *Tyrannosaurus rex* typically ranges between 18,000 and 35,000 N (e.g., Rayfield, 2004; Gignac & Erickson, 2017) with some studies suggesting higher values (ca. 49,000 N; Sakamoto, 2022). These values, alongside fossil evidence such as bite marks (Erickson and Olson, 1996) and coprolites (fossilised faeces) with high proportions of bone fragments (Chin et al., 1998), suggest that T. rex was easily capable of crushing and consuming bone, akin to the Rancor (e.g., Gignac & Erickson, 2017; Sakamoto, 2022). FEA has also been undertaken to assess the bite force of other iconic palaeopredators, such as giant Devonian placoderm *Dunkleosteus terrelli* (ca. 5,300 N; Anderson & Westneat, 2007) and the famous sabrecat *Smilodon fatalis* (ca. 1,000 N; McHenry et al., 2007), however, these organisms have much lower bite forces than the theropod dinosaurs (and the Rancor).

Digital modelling and simulation techniques have considerably changed how extinct organisms can be studied and contributed a wealth of new data that would otherwise be difficult to obtain. This study follows the same methodological approach and is not fundamentally different from the investigation of the functional morphology and ecology of fossil vertebrates. In both fossils and intergalactic predators, such as the Rancor, it is very dangerous (or impossible) to take *in vivo* measurements and to observe behavioural aspects. Digital analyses can, therefore, provide additional information and permit non-invasive hypotheses-testing approaches. However, despite the versatility of digital investigations, there are some uncertainties inherent to these techniques that should be considered. Firstly, muscle reconstructions follow modern examples and assume similar muscle arrangement and architecture for fossil/intergalactic vertebrates. While muscles are fairly conserved across different animal groups (Hirasawa & Kuratani, 2018), individual differences in the number of muscle fibres, fibre length, and muscle pennation (i.e. muscle fibres attaching to tendons rather than directly to skeletal elements) etc. can change the maximal possible muscle force and tension. It is therefore likely that digital muscle reconstructions underestimate overall muscle forces due to the difficulty in reconstructing the internal muscle architecture. Secondly, for functional analyses, such as FEA, certain simplifications and assumptions have to be made. Similar to muscles, bone is generally similar across a wide range of vertebrate groups (Huttenlocker et al., 2013). However, some vertebrates may have evolved specific adaptations: for example, bird bones are lightweight and hollow to facilitate flight, while aquatic species (e.g., whales and their ancestors) typically have adapted to the need for buoyancy with the development of dense and compact bones (Houssaye, 2022). It is therefore important to use correct material properties reflective of a species' bone architecture for functional simulations (Bright, 2014).

While such material properties are known for more commonly studied vertebrates, obtaining the same for fossil/intergalactic species is challenging – with fossil material, the original bone has been replaced and remineralised during the fossilisation process. Therefore, using material properties from closely related or functionally equivalent species can minimize uncertainties but, similar to muscle reconstructions, the skeletal stability may be underestimated. Regardless of these uncertainties, the results from this study demonstrate that the Rancor could exert some of the bite forces larger than most organisms that have existed on Earth – easily capable of breaking robust long bones inserted into its jaw longitudinally – a feat not commonly replicated in nature. Moreover, our model indicates that the skull and lower jaw of the Rancor experienced relatively low stresses that would not pose a risk of damage to its own skeleton.

CONCLUSION

By reconstructing the skeletal anatomy and using Finite Element Analysis, a technique commonplace in palaeontological science, we have estimated the bite force of the iconic Rancor, the intergalactic predatory 'reptomammal' from *Return of the Jedi*. We estimate that the Rancor would have been able to generate a bite force of ca. 44,000 N. This value far exceeds the strength of bone, indicating that the Rancor to easily snap a large mammalian femur that had been placed longitudinally in its jaw. Moreover, our model demonstrates that the Rancor's skull and jaw would have been able to withstand the stresses exerted on them as the long bone shattered. While our model relies on several assumptions (some typical of palaeontological research and some due to the intergalactic nature of this study), we suggest that the Rancor's bite force far exceeds any extant organism and is comparable to the large predatory theropod dinosaurs such as *Tyrannosaurus rex*.

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Archaeolinguistics and language deciphering in action-adventure video games: *Indiana Jones*, *Tomb Raider* and *Uncharted*

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Popular action-adventure video game franchises have long captured audiences with their mix of ancient mysteries and lost treasures. These stories often feature protagonists busy exploring ancient ruins as a way to discover forgotten civilisations. At the heart of these narratives lies a crucial component: language. In these media, languages play an indispensable role in story progression via the deciphering of ancient texts and cryptic symbols. However, this is an aspect that has been largely overlooked in scholarly works within linguistics and video game studies.

For the purpose of this paper, we will use the term "archaeolinguistics" to refer to the study and deciphering of language data, either spoken or written, as found in archaeological artifacts and evidence, as a way to uncover the languages and cultures of past civilisations (Carling, 2024). The term "action-adventure video game" refers to games that combine action-oriented gameplay—such as controlling a character through various biomes and navigating environmental obstacles (through jumping, crouching or running, for instance)—with adventure mechanics, which involve actively exploring surroundings by searching for items, clues, artifacts, and solving puzzles. Here, we are interested in examining cases where protagonists in these media encounter historical artefacts, often discovered at the end of exploratory journeys in various game environments, such as caves, tombs, mazes, forests and similar. These artefacts are frequently coveted remnants of long-lost civilisations and sometimes include inscriptions in foreign, occasionally dead, languages. Poignant video sequences often depict protagonists gazing at these artefacts with bright eyes, eager to uncover the history behind their discovery. However, the linguistic aspect of these artefacts is not always the central focus, as the wealth and/ or fame gained from their discovery often takes precedence. As such, the representation of language and archaeolinguistics in action-adventure franchises often prioritises entertainment over accuracy, reducing the complex realities of archaeolinguistics to superficial narrative devices, something that also applies to the representation of history in video games in more general terms (Kapell & Elliott, 2013). Indeed, similar inaccuracies have been observed in the broader depiction of archaeology in popular culture as well, which is frequently oversimplified and presented as a treasure-hunting endeavour designed to advance the plot rather than as a time-consuming process, as it is in reality (McGeough, 2006; Marwick, 2010; Reinhard, 2018). Holtorf (2007) adds that archaeology is often reimagined as a "brand," capitalising on its adventurous aspects while ne-

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glecting its practical complexities. This oversimplification extends to the portrayal of ancient languages in video games, where linguistic challenges are often reduced to convenient narrative tools rather than reflecting the depth of real-world language study.

Real-world archaeolinguistics is a meticulous field, rooted in the study of ancient scripts and language change and the cultural contexts of these (Carling, 2024). The process of deciphering inscriptions or reconstructing lost languages often spans years. In contrast, adventure media often portrays linguistic challenges as puzzles to be solved as part of the video game plot, with very little space sometimes dedicated to the historical significance of language itself. As a result, this simplification, while engaging, risks perpetuating misconceptions about the intellectual dimensions of archaeology and linguistics.

This paper examines three action-adventure video game franchises: (1) *Tomb Raider*, (2) *Indiana Jones* and (3) *Uncharted*, to explore how they construct the role of language in archaeological discovery. Rather than focusing on the "language of gaming" (Ensslin, 2015) or language learning through gaming (Ryu, 2013), this paper shifts its attention to the *representation* of language learning and deciphering *in* gaming, an aspect that has been fairly neglected in game studies. I propose calling this phenomenon a "meta-language dynamic," as it examines how language itself is framed within these narratives. The franchises were chosen for their widespread popularity and for their key role in introducing archaeological practices to a broad audience. As such, they play a key role in shaping audiences' perceptions of what it means to be an archaeologist, or an explorer engaged in language deciphering. Lara Croft's explicit, skill-based journey in the *Tomb Raider* reboot trilogy, where she gains linguistic proficiency through deliberate effort, offers a rare example of a video game protagonist actively engaging with language acquisition. In contrast, Indiana Jones and Nathan Drake, iconic male adventurers, are often depicted as effortlessly fluent in ancient languages, embodying the image of a hypercompetent Western scholar-adventurer, as already noted by McGeough (2006, p. 176). The analysis has a threefold aim: (1) to examine how the narratives of the three franchises, particularly their plots, incorporate language learning and deciphering; (2) to investigate how, and to what extent, these elements are integrated into gameplay mechanics; and (3) to explore broader processes at play, including the gendered dynamics of these portrayals. Through this analysis, I argue that the representation of language in these franchises mirrors their broader treatment of archaeology in popular culture—visually spectacular, yet reductive.

LITERATURE REVIEW

The intersection of linguistics, media studies and archaeology within action-adventure video games remains an underexplored area of academic inquiry. While there has been substantial work on the representation of archaeology in popular media and culture (McGeough, 2006; Holtorf, 2007; Reinhard, 2018) and on the language of videogames (Ensslin, 2015; Hsu, 2020), the role of language learning and archaeolinguistics as a gameplay device has received comparatively little attention, with scattered mentions present but mostly in non-academic platforms, such as game reviews, or academic dissertations (Dennis, 2019; Casimir, 2021).

Academic research on language learning through video games has grown in recent years. For example, studies in digital game-based language learning (DGBLL) demonstrate that gaming can facilitate vocabulary acquisition and engagement with new languages (Ryu, 2013). Such studies have found that gaming culture and online gameplay provide informal environments where players pick up new words and phrases, effectively learning through play. However, the majority of this sort of research focuses on players learning real lan-

guages (e.g. English as a second language) rather than on how games depict characters *within* the game learning or deciphering languages. Thus, scholarship on the 'language of video games' certainly exists, yet the representation of language learning as a gameplay mechanic definitely remains under-examined.

Scholarly critiques of archaeology in popular media often highlight the romanticised portrayals of the discipline, where complex research processes are reduced to treasure-hunting expeditions, reflecting broader trends in video games where simplification of historical narratives is often preferred. McGeough's (2006) study on *Indiana Jones* critiques the franchise for perpetuating colonial narratives, presenting Western adventurers as the rightful interpreters of ancient artefacts. Similarly, Reinhard (2018) explores the ethical implications of archaeological representation in video games, discussing how these portrayals can reflect broader issues of historical bias. As a result, the public's understanding of archaeology often skews toward the fantastical. Reinhard (2018) notes that video games blur the boundary between archaeology and looting, letting players engage in illicit treasure hunting with few repercussions, calling the process as a form of digital "cultural appropriation". This can reinforce the idea that archaeology is solely about grabbing artifacts for personal gain and prestige. Crucially, languages and inscriptions, which are central to real archaeological research, tend to be treated in games as mere steppingstones to the next plot point. Ancient scripts are usually presented as *puzzles* solved instantly by the hero, thereby underplaying the years of study real decipherment requires. The result is a potential misconception about linguistic work: players may assume that decoding a dead language is quick and straightforward rather than a painstaking collaborative process. On the other hand, incorporating languages can also pique player curiosity about ancient cultures. DaCosta (2024) argues that commercial games *can* foster cultural heritage awareness if handled thoughtfully. His case study on *Shadow of the Tomb Raider* suggests that when developers collaborate with historians, archaeologists, and indigenous communities, games may portray archaeology (and by extension epigraphy and linguistics) with more respect for accuracy and local context. In short, these popular games have a double-edged influence: they spark interest in archaeology and ancient languages on a broad scale, but they also risk entrenching simplistic or mistaken ideas about how those fields work.

In terms of video games that are centred on language decipherment, on top of the ones that are the focus of this study, there are a few media that essentially offer a *gamified* experience of linguistics, namely, *Heaven's Vault* (Inkle, 2019) and *Chants of Sennaar* (Rundisc, 2023). The first one is a narrative sci-fi archaeology game where the central gameplay mechanic is attempting to decipher a lost writing system by an ancient civilisation while the second one has players decode ancient languages as core gameplay. These examples show the potential of interactive media to engage players in language learning as part of the narrative. By turning translation and linguistic analysis into puzzles, such games effectively "gamify" the decipherment process—making the player learn the language in order to progress. This trend has attracted some academic attention; for example, the CREWS project examined how Heaven's Vault handles invented scripts, applauding the authentic epigraphic methods used in gameplay (Boyes, 2019).

The representation of gender in adventure media, particularly regarding protagonists' intellectual and physical abilities in video games, has been widely studied (Schleiner, 2001; Kennedy, 2002; Consalvo, 2004; Jansz & Martis, 2007; McInnes, 2016; Engelbrecht, 2020;). A significant body of research has examined *Tomb Raider*, often as a case study for the ways female protagonists are framed in terms of competence within adventure games. This scholarship will provide a critical foundation for my own analysis in the discussion section. In this sense, scholars have examined how gender dynamics play out in the portrayal

of knowledge within adventure games. Historically, media often depicted male characters as natural intellectual authorities—the professors, explorers, and code-breakers—while female characters were sidekicks or love interests, valued for loyalty or beauty over expertise. Even in games, this trend persisted for years. In early adventure titles (and their film inspirations), it is typically a male hero who effortlessly deciphers clues and ancient texts. For example, the iconic *Indiana Jones* is a professor of archaeology who can read multiple dead languages on the fly; the audience simply accepts Dr. Jones's erudition as part of his heroic persona. Likewise, *Uncharted*'s Nathan Drake is portrayed as a globetrotting polyglot who never struggles with a translation—ancient symbols conveniently "make sense" to him, reinforcing the trope of the *effortlessly educated* adventurer. This *effortless fluency* is a form of gendered framing, aligning with broader media patterns where men are assumed to possess authoritative knowledge by default. By contrast, when Lara Croft debuted in *Tomb Raider* (Core Design, 1996), she was one of the few female leads in the genre—a highly educated archaeologist in her own right. Schleiner (2001) highlights how Lara Croft's character embodies a clear paradox: she challenges traditional gender roles by being tough, resourceful, and intellectually capable, yet simultaneously appears hypersexualised, almost as a digital pin-up. Despite this tension, Lara's emergence marked a significant turning point. In the rebooted *Tomb Raider* games (2013–2018), the developers emphasise Lara's academic and linguistic abilities even further, a point I will return to later in this paper.

Another critical lens in recent scholarship is the postcolonial critique of how adventure games frame Western heroes as cultural and linguistic authorities in non-Western settings. These games often draw on colonial-era adventure stereotypes: a Western explorer penetrates the "mysterious Orient" or remote indigenous lands, decodes the secrets, and claims the treasures (or knowledge) for humanity—implicitly, for the West. Edward Said's concept of *Orientalism* (1978) is frequently invoked to explain this dynamic, wherein the East is portrayed as passive, its knowledge and heritage waiting for a Westerner to interpret and valorise. In *Tomb Raider* and *Uncharted*, the protagonist is typically a white European or American who handily outsmarts local people about *their own* past. This has led scholars to criticise the "white saviour" narrative prevalent in such games. Villahermosa Serrano (2023), writing on *Shadow of the Tomb Raider*, points out that Lara Croft (despite her good intentions) embodies a familiar pattern: *she* takes custody of indigenous artifacts "in order to protect and preserve them," on the presumption that only someone like her can properly care for or comprehend these items. The game thus implies that the original Indigenous owners or descendants "*cannot*" understand or safeguard their own cultural heritage, requiring a Western hero to do it for them.

Beyond narrative framing, scholars have critiqued specific instances of cultural and linguistic representation in these games. Maya, Inca, and Aztec cultures are often mishmashed into a generic "ancient civilisation" for a Western hero to discover. This kind of simplification, though done for game convenience, can be seen as erasing the real diversity of Indigenous cultures. Even when games try to be respectful, they sometimes fall into the trap of exoticising locals as primitive or mystical while the Western hero is the rational saviour. For instance, Lara Croft in *Shadow of the Tomb Raider* is portrayed as the one who must intervene and protect the inhabitants of Paititi from an apocalypse, effectively a white saviour protecting the natives. Such imagery carries the baggage of what Villahermosa Serrano (2023) calls the "*neocolonial imaginary*" in video games. It caters to Western audiences by using exotic settings as playgrounds and positioning Western characters as benevolent conquerors of knowledge and power. Champion (2017) playfully coins the term "Single White Looter" to describe this recurring pattern—the solitary white adventurer who casually raids foreign tombs—and points out how wide-

spread this portrayal remains in video games dealing with historical themes.

Theoretical frameworks of ludology and narratology will be essential for understanding how action-adventure games integrate language into their mechanics and storytelling. Ludology, as outlined by Frasca (2004), focuses on "creating typologies and models for explaining the mechanics of gameplay," and will provide tools for analysing how games like *Tomb Raider* and *Indiana Jones* incorporate language learning as a player-driven process. Linguistic challenges in action-adventure games sometimes require nontrivial player interaction, aligning with Aarseth's concept of "ergodic literature" (1997), where the audience must actively engage with the text to interpret its meaning. In video games, this concept is often balanced with a design intent to avoid overwhelming the player, focusing instead on maintaining gameplay accessibility. Gee (2003) expands on this by emphasising how games function as "situated learning environments" where players acquire knowledge through immersive experiences. This work will be instrumental in analysing how linguistic problem-solving is framed in adventure media, particularly how *Tomb Raider* encourages players to develop linguistic proficiency as an embodied process. Narratology, on the other hand, examines how linguistic elements serve broader storytelling goals, such as character development and world-building (Chatman, 1980; Genette, 1980; Bal, 1985). Gee's (2003) framework of "projective identity" further reinforces this analysis by demonstrating how players merge their real-world knowledge with their in-game character's evolving expertise.

Much of the existing scholarship tends to focus on either the ethical dimensions of archaeology or on the role of language in world-building. However, little attention has been given to how adventure media frames language learning and decipherment as fundamental to the process of archaeological discovery. The act of decoding ancient scripts and reconstructing lost languages is often central to narratives in this genre, yet its portrayal is rarely examined critically. This gap in the literature suggests the need for a more focused inquiry into how adventure media constructs the relationship between archaeology and linguistics, particularly in shaping public perceptions of linguistic reconstruction.

The following three sections of this paper will explore these issues by examining each of the franchises in turn—*Indiana Jones*, *Tomb Raider* and *Uncharted*—in view of situating their portrayals within the broader theoretical frameworks discussed above.

INDIANA JONES

Indiana Jones video games were most prolific during the 1980s and 1990s, with the franchise seeing a significant decline in major releases over the past two decades. The last notable entry based on the traditional movie format was *Indiana Jones and the Staff of Kings* in 2009. As such, the release of *Indiana Jones and the Great Circle* in 2024, published by Bethesda Softworks, was a highly anticipated and welcome surprise for fans eager to revisit the iconic adventurer in a new gaming format. The game brings a fresh perspective to the adventurer's escapades by focusing on immersive puzzles and stealth gameplay. It tasks players with uncovering the secrets of the *Great Circle*, a legendary network of ancient civilisations, and with guiding Indiana Jones through various archaeological sites, where the protagonist engages with intricate challenges that sometimes involve cryptographic and linguistic puzzles. This instalment stands out by making language learning and deciphering ancient scripts a core part of the gameplay experience. Unlike the movie representations of Indiana Jones, where his linguistic abilities are largely taken for granted, *The Great Circle* places greater emphasis on the process of understanding and interpreting language. One standout example is the "Chamber of Resonance Puzzle," set in the Gizeh (Egypt) section of the game (Fig. 1). Here, players encounter tablets inscribed in ancient languages, which must be

photographed and carefully analysed to determine the correct sequence of words. This puzzle demands an understanding of the linguistic context, requiring players to interpret the meaning of inscriptions rather than simply recognising symbols. The process reflects a more immersive and thoughtful approach to archaeolinguistics, encouraging players to engage with the historical significance of the languages depicted.

Figure 1. The "Chamber of Resonance Puzzle" in *Indiana Jones and the Great Circle* (Bethesda Softworks, 2024), set in Gizeh, Egypt. Players analyse ancient tablets by taking pictures of them with the in-game camera tool and interpreting inscriptions to determine the correct sequence of words. Source: screen capture from the game.

Another notable challenge is the "Counting Letters Mystery", which presents players with a coded message that must be deciphered using code wheels and frequency analysis tables. This puzzle mirrors real-world cryptographic techniques, requiring players to identify patterns and letter frequencies. The game aligns linguistic problem-solving with the intellectual rigour of archaeological discovery, making language deciphering feel integral to the gameplay. The "Kummetz Cipher Puzzle," encountered aboard the KMS Kummetz, takes this engagement a step further by introducing a disassembled cipher machine (Fig. 2). Players must locate and assemble code wheels, then use a code table to translate letters into a numeric code. This puzzle offers a practical simulation of historical encryption methods, basing its depiction on real-world cryptographic practices. It also emphasises the collaborative and methodical nature of deciphering, which is often overlooked in adventure media. The "Father and Son Safe Code Puzzle," instead, adds a literary dimension to the linguistic challenges by combining a Polybius Square diagram with an Italian poem. Players are tasked with analysing the poem and using the diagram to convert letter pairs into numbers to unlock a safe.

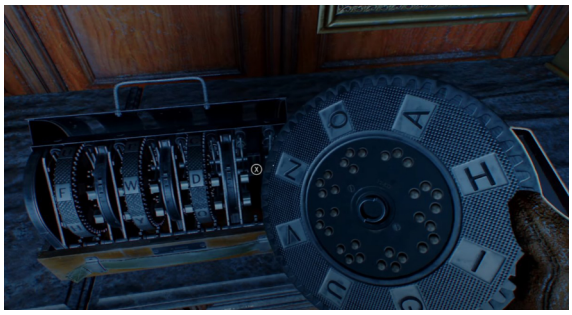

Figure 2. The "Kummetz Cipher Puzzle" from *Indiana Jones and the Great Circle* (Bethesda Softworks, 2024), showing the disassembled cipher machine aboard the KMS Kummetz. Players reconstruct the cipher wheels and use code tables, simulating historical cryptographic methods. Source: screen capture from the game.

There are also other depictions of language-learning moments scattered throughout the plot. The game, for instance, includes mentions of Adamic, a language referenced in some Jewish and Christian texts, which was supposedly used by Adam. It is presented as the first human language ever used and is found on some of the artifacts discovered by Indiana throughout the game, showing as using a logographic script. In one segment, while the crew is traveling to the Himalayas aboard a ship, Indiana is shown reading from his notebook, repeating words in Adamic as a way of revising his vocabulary. The plot also introduces the character of Laura Lombardi, an Italian archaeolinguist renowned for her expertise in ancient languages. She is eventually recruited by the Nazis and

forced to assist in the deciphering of Adamic artifacts at Machu Picchu. The inclusion of Laura Lombardi as a linguist is significant because it highlights the crucial role that language plays in unlocking historical mysteries. Even though Laura is not a playable character, her presence is an important piece of the puzzle that drives the plot, as her sister, Gina, joins Indiana in the search for the Nazi to discover what happened to Laura.

I want to commend the publisher here, as these language-related narratives, together with the linguistic puzzles, promote a deeper engagement with linguistics than the movies' portrayals of Indiana Jones as a hyper-competent individual who effortlessly translates ancient texts. These dynamics invite the players to immerse themselves in the complexities of language learning (even if the language is artificial) and move away from depictions of protagonists whose language fluency is simply assumed.

Another important aspect to consider is that Indiana Jones, across the franchise, frequently interacts with locals during his travels, often relying on first-language speakers to mediate his linguistic experiences. This approach definitely promotes a more inclusive representation of the language (but also cultural) environment.

Critically, this shift has been well-received by both players and reviewers, who praised the game's incorporation of authentic code-deciphering mechanics. Reviews in online gaming magazines and news outlets, although not specifically mentioning the linguistic component, often highlight the puzzles as a refreshing addition that deepens the player's sense of discovery (Lane, 2024; Reilly, 2024; Wald, 2024).

However, while the game's puzzles reflect a commendable effort to engage with linguistic elements, they remain inherently gamified, with predefined solutions that limit the open-endedness of real-world linguistic and archaeological inquiry. Additionally, there are still moments where the polyglot adventurer stereotype is still shown. A demonstration of Indiana's expected linguistic proficiency occurs during the scene on the KMS Kummetz in the Himalayas, where he narrowly escapes being captured by the Nazis. At one point, a Nazi officer asks him if he has "Höhenangst," and Indiana immediately wittily responds, "Fear of heights?"—showcasing not only his fluency but his ability to respond to such specialised terminology with ease, even in very stressful situations. Similar language fluency is then on display during the subsequent trip to Thailand, with Indiana showing off his Thai skills with the locals. Nonetheless, *Indiana Jones and the Great Circle* marks a significant step forward in the representation of language learning in adventure media, offering a more immersive and respectful portrayal of linguistics as a vital component of archaeological discovery, rather than simply relying on the protagonist's expected linguistic knowledge in passing, inviting the player to reflect on it, creating a meta-language dynamic.

TOMB RAIDER

The *Tomb Raider* reboot trilogy (2013–2018) offers one of the most deliberate and explicit portrayals of language learning and deciphering among adventure franchises. The second game of the trilogy, in particular, features Lara Croft's ability to understand ancient scripts. In this case, language learning is not simply presented as an innate skill but as a process of discovery, tied directly to gameplay. This approach stands out within the genre, highlighting the importance of language acquisition as a tool for archaeological exploration and intellectual growth.

In *Rise of the Tomb Raider* (2015), language learning becomes a core mechanic. Lara encounters inscriptions written in Greek, Mongolian and Russian throughout her journey, each tied to different contexts and environments. Greek inscriptions often relate to Byzantine artefacts and Christian relics (Figs 3, 4), Mongolian texts connect to the Mongol Empire and the Silk Road and

Russian inscriptions reflect Soviet activity and their influence on the game's setting. As Lara gains proficiency in these languages, she can read monoliths that reveal the locations of hidden treasures and resources on the map, adding an exploratory element to the gameplay. To decipher these texts, players must guide Lara through interactions with murals, earning experience points that increase her proficiency in these specific languages. If Lara hasn't achieved the necessary language level, the player is warned that she cannot read the inscription (Fig. 5). These are effectively "early archaeological records and thus […] objects of importance to the local people" (DaCosta, 2024). In a media interview (Kamen, 2015), senior designer Michael Brinker explained that this mechanic was not introduced simply as a language learning endeavour per se but as a way to use language to find "more ancient secrets." Still, from a language acquisition point of view, this mechanic mirrors a real-world learning curve, albeit simplified, where progress is incremental. The language acquisition process is gamified but the publisher has managed to make learning languages feel integral to Lara's development as an adventurer, providing narrative depth and rewarding players for engaging with the linguistic aspects of the gameworld. Narratively, it emphasises Lara's intellectual curiosity, aligning her with the archetype of the scholar-adventurer, but it also reinforces the idea that linguistic competence is an earned skill, challenging the expectation that protagonists should possess pre-existing language fluency.

However, the whole process is not as fleshed out or developed as it could be. The language learning indeed often becomes a matter of "check this inscription" or "find that artefact," reducing language acquisition to a button pressing exercise. This gamification, while effective in maintaining pacing, oversimplifies the often-painstaking process of linguistic proficiency attainment. Indeed, one can finish the main story without fully engaging in this system—and online reviews have indeed mentioned this as a disappointing missed opportunity, saying that the "crux of the issue is that language learning is not essential to advancing" the game (Andrew, 2020). As a player, it even borders on the comical—as Lara, with the press of a button, instantly acquires substantial knowledge of a language simply by reading a random inscription on a stele. Nevertheless, this mechanic indeed adds a notable layer of intellectual engagement to the game, despite the inscription deciphering feeling overly simplistic, primarily consisting of a straightforward "click on the stone and move on" interaction. Note that the language learning mechanic was kept in the final game of the trilogy, *Shadow of the Tomb Raider* (2018), where Lara deals with Yucatec Maya, Quechua and Mam transcriptions, although the dynamic is somewhat less prominent in this videogame.

Figure 3. Lara Croft examining a Greek inscription in *Rise of the Tomb Raider* (Crystal Dynamics, 2015). Deciphering these inscriptions is tied to a gameplay mechanic, representing incremental language learning as part of the archaeological exploration. Source: screen capture from the game.

Critically, the inclusion of language mechanics in *Rise of the Tomb Raider* received mixed responses. Some reviewers appreciated the attempt to deepen the archaeological experience while others did not think that it merged well with the rest of the gameplay. For instance, a review in the *New Game Network* by Hinke (2015) noted that "there isn't much [a player] can do with this skill." It is clear that the language mechanic

is an overall welcome addition but yet it feels like a superficial one. The sense of intellectual engagement is definitely there, as players unlock secrets through translation. However, its practical impact feels limited, as there are few moments where these skills are genuinely required.

Figure 4. After deciphering a monolith in *Rise of the Tomb Raider* (Crystal Dynamics, 2015), an on-screen icon indicates Lara's current language proficiency and progression level. Interacting with murals grants experience points, incrementally enhancing her ability to interpret ancient languages. Source: screen capture from the game.

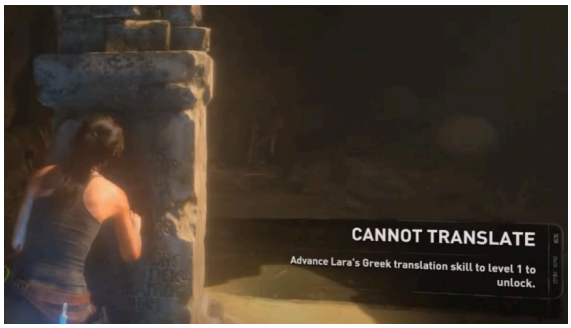

Figure 5. Gameplay screenshot from *Rise of the Tomb Raider* (Crystal Dynamics, 2015) demonstrating a language proficiency warning. If Lara's linguistic skill level is insufficient, players receive a notification that she cannot yet translate certain inscriptions. Source: screen capture from the game.

Overall, the game deserves praise for integrating language learning into its mechanics, even though it ultimately simplifies the complexities of archaeolinguistics. While it is true that the progression system reduces language acquisition to a linear process, omitting the inherent challenges of real-world linguistic study, it remains a rare example of how language learning can be meaningfully incorporated into gameplay centred on archaeological exploration. At the same time, it subtly challenges the genre's reliance on the effortlessly polyglot explorer. In summary, I believe *Tomb Raider* series' effort to incorporate language learning into its mechanics represents a commendable step.

UNCHARTED

The *Uncharted* series, starring Nathan Drake, has become a cultural phenomenon in adventure gaming, combining cinematic storytelling with action. The franchise has also inspired a fairly recent movie (Sony Pictures, 2022) starring Tom Holland as the protagonist. Central to Drake's adventures is the recurring theme of deciphering ancient texts and symbols, often tied to the discovery of legendary treasures. However, unlike other video game franchises such as *Tomb Raider* or *Indiana Jones and the Great Circle*, *Uncharted* treats language as a largely incidental element of its narratives. Nathan Drake's linguistic capabilities are portrayed as inherent and effortless, with little attention given to the process of language learning or the complexities of interpretation.

One of the widely acclaimed entries in the series, *Uncharted 4: A Thief's End* (2016), demonstrates this tension. In his quest to uncover the lost pirate colony of Libertalia, Drake encounters numerous puzzles, including pirate symbols, ancient maps and inscriptions. For instance, players are tasked with solving puzzles based on the symbols of Henry Avery and his pirate crew (Fig. 6). These puzzles often involve matching symbols or interpreting their placement within the environment. While

entertaining, they lean more on visual pattern recognition than linguistic analysis. The symbols function primarily as mechanical tools to advance the plot rather than as artefacts with historical significance. A similar dynamic can be observed in earlier entries. In *Uncharted 2: Among Thieves* (2009), Drake navigates ancient Himalayan temples, where he interprets symbols and artefacts to progress. In *Uncharted 3: Drake's Deception* (2011), the narrative delves into Arabic inscriptions and the lore of the Arabian Peninsula. However, in both cases, Drake's fluency in these languages is assumed, and the texts are conveniently translated with minimal effort. The games rarely explore how Drake acquired his linguistic expertise, presenting it instead as a given aspect of his adventurer persona. This aligns with the genre expectation of the hyper-competent protagonist, whose mastery of languages is just another tool in their repertoire, akin to firing a weapon.

Figure 6. Puzzle sequence from *Uncharted 4: A Thief's End* (Naughty Dog, 2016), featuring pirate symbols associated with Henry Avery's lost colony of Libertalia. Source: screen capture from the game.

This lack of depth extends to how the series portrays the cultural significance of language. Ancient texts and symbols are often stripped of their historical contexts, existing solely as puzzles for the player to solve. For example, in *Uncharted 4*, the pirate artefacts are used to reveal clues about Libertalia's location but are not deeply explored as cultural products of their time. The focus remains on their function within the treasure-hunting narrative, but there is no mention of how these artefacts are key to understanding the societies that produced them.

Critically, the representation of language in *Uncharted* has drawn limited attention in reviews, as the franchise's emphasis on action and cinematic storytelling often eclipses its intellectual elements, reflecting broader trends in gaming culture that prioritise action-oriented narratives. For example, IGN's review of *Uncharted 4* (O'Brien, 2016) highlighted the engaging puzzles as a way to break up the action but did not delve into how language played a role in those sequences. This oversight reflects the broader treatment of language learning in the series as a functional but underdeveloped aspect.

In summary, while *Uncharted* excels in delivering cinematic adventure, its treatment of language remains superficial, prioritising action and accessibility over intellectual complexity. The franchise's reliance on the protagonist's innate linguistic fluency mirrors its broader approach to archaeology as a treasure-hunting endeavour, reinforcing genre conventions that prioritise spectacle over substance.

A COMPARATIVE ANALYSIS ACROSS THE THREE FRANCHISES

The portrayal of archaeolinguistics and language learning in *Tomb Raider*, *Indiana Jones* and *Uncharted* offers a unique opportunity to examine how adventure media engages with the intellectual challenges of deciphering ancient texts. While all three franchises integrate linguistic elements to varying degrees, their approaches reflect distinct priorities.

Rise of the Tomb Raider (2015) stands out for its deliberate focus on language learning as a core gameplay mechanic. Lara Croft's journey to increase her proficiency in ancient languages ties language learning directly to her character development. This creates what Gee calls "situated" learning experiences where players engage with new knowledge through "embodied" interaction (2003, pp. 83–84). In *Tomb Raider*, lan-

guage learning is not an abstract skill but a tool necessary for progressing in the game world—a tool that players have to physically engage with by clicking on objects around them. However, this gamified approach slightly simplifies the complexities of real-world language learning, reducing language to a linear progression of "click-a-stone" mechanic.

In contrast, *Indiana Jones and the Great Circle* strikes a balance between gameplay and intellectual engagement, offering linguistics-driven puzzles that require active problem-solving. Additionally, it also includes a plot that features characters who are actual archaeolinguists and hold a central role in the narrative development. Unlike *Tomb Raider*, where language is tied to progression through a levelling mechanic, *Indiana Jones* presents puzzles that demand context-based interpretation and the application of cryptographic techniques. This creates a "projective identity" (Gee, 2003, p. 98), where players are immersed in a new environment and take the role, and the identity, of the character on the screen—an archaeolinguist in this case—rather than simply acquiring a skill passively. These challenges emphasise the collaborative aspects of language learning, aligning more closely with real-world archaeolinguistic practices, while still adhering to the gamified constraints of the medium. *Uncharted*, however, takes the most superficial approach to language learning. Nathan Drake's fluency in ancient and modern languages is assumed rather than earned, serving as a narrative convenience rather than a focal point of his character.

By making language a central gameplay element, *Indiana Jones and the Great Circle* aligns more closely with *Tomb Raider*'s depiction of linguistics as an intellectual endeavour. In *Tomb Raider*, deciphered inscriptions also often reveal contextual details about the societies Lara explores, thus deepening the player's immersion in the gameworld. This is an example of how video games function as "semiotic domains" (Gee, 2003)—systems of meaning where players must engage with complex interpretative tasks that extend beyond simple mechanics. Aarseth's (1997) concept of ergodic literature further supports this idea, as players must actively navigate linguistic challenges, participating in the meaning-making processes of gaming, which in turn fosters deeper player engagement. This dual function of language—as a gameplay mechanic and a means of engaging with cultural heritage—distinguishes *Tomb Raider* from its counterparts.

Analysed through a ludology lens, the game mechanics across the three franchise show varying tendencies. *Tomb Raider* and *Indiana Jones* integrate linguistic challenges into their interactive systems, encouraging players to actively engage with language. From a narratological perspective, *Uncharted* features language elements primarily as a plot shortcut, while in *Tomb Raider* and *Indiana Jones*, they contribute to world-building and character development.

From a postcolonial theory perspective, Western-centric narratives are still present. The profile of the Western adventurer as the sole interpreter of ancient knowledge is still prevalent, particularly in *Uncharted* and *Indiana Jones* media. Although, in *Indiana Jones*, locals are at times involved in conversation by travelling and exploring together with the protagonist. By contrast, the active learning mechanics in *Tomb Raider* offer a more respectful portrayal of archaeolinguistics and language learning, emphasising the intellectual curiosity involved.

Finally, the depiction of language learning in these franchises raises important questions about the ideological messages embedded in their gameplay, on top of revealing significant gendered dynamics. In *Tomb Raider*, Lara's linguistic abilities are depicted as the result of effort and intellectual curiosity. Her progression reflects the importance of study and growth. This portrayal contrasts sharply with *Uncharted* and *Indiana Jones*, where male protagonists possess pre-existing linguistic fluency. Wood (1994) highlights how media industries reinforce traditional gender norms by portraying male characters as authoritative while depicting female characters in more

subordinate roles. The assumption of linguistic fluency in male protagonists like Indiana Jones and Nathan Drake reinforces these traditional notions. This portrayal contrasts sharply with the depiction of Lara Croft, whose linguistic competence is earned through visible effort. The gendered dynamics of these representations echo broader cultural assumptions about intellectual labour: male characters are presumed to possess mastery, while female characters must prove their abilities through arduous processes. There is to note that *Tomb Raider* has been praised before for being among the first major Western video games to prominently feature a solely female protagonist, and Lara's journey reflects a shift in how female protagonists are portrayed, challenging traditional gendered assumptions in video games. Indeed, this topic has inspired prolific scholarly work across the years (Schleiner, 2001; Kennedy, 2002; McInnes, 2016; Engelbrecht, 2020).

CONCLUSION

The examination of language learning and archaeolinguistics across *Tomb Raider*, *Indiana Jones* and *Uncharted* highlights the diverse ways adventure media engages with the complexities of linguistic study. Each franchise incorporates language as a narrative and/ or gameplay element although their representations vary significantly in depth. *Tomb Raider* emerges as the most deliberate in its approach, portraying language learning as a skill tied to intellectual growth. *Indiana Jones and the Great Circle* bridges intellectual engagement with entertaining gameplay through linguistics-driven puzzles that demand active problem-solving. While these elements remain inherently gamified, the game sets a new standard for how archaeolinguistics can be portrayed in adventure media. *Uncharted* instead offers a more superficial treatment of language, relying on Nathan Drake's presumed fluency. Here language functions primarily as a narrative shortcut, an approach that prioritises the franchise's emphasis on action but sacrifices opportunities for meaningful engagement with linguistic heritage.

The portrayal of archaeologists and ancient languages in adventure games has cultural implications. While these games can spark interest in archaeology, history, and linguistics, they also risk reinforcing misleading stereotypes. Players may come away with the misconception that archaeology is about treasure hunting or that linguistic decipherment is a quick, solitary process, whereas in reality, both fields require rigorous analysis and collaboration. Additionally, the erasure or stereotyping of local cultures perpetuates a Western-centric perspective, influencing how global audiences engage with their own heritage.

These portrayals reflect broader cultural narratives about who holds the right to interpret ancient languages and highlight gendered assumptions about intellectual effort. These differences reveal trends in how adventure media approaches archaeolinguistics. The emphasis on spectacle and accessibility often overshadows the intellectual dimensions of language. However, the increasing integration of language learning mechanics and linguistics-driven puzzles in recent media suggests a growing recognition of the potential for archaeolinguistics to enrich storytelling. Future adventure media could build on these developments by embracing the complexities of language and its role in archaeological discovery. This includes incorporating collaborative elements, contextualising linguistic challenges within broader cultural narratives and challenging the colonial undertones of traditional portraits. Through this analysis, this paper contributes to the broader discourse on the intersections of linguistics, media studies and archaeology, advocating for representations that respect the richness and complexity of language learning.

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About the author

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Pokérus: unraveling the biology of the Pokémon virus

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Since their discovery, viruses have had a poor reputation as being synonymous with infectious diseases. These ubiquitous entities can cause illnesses ranging from mild to fatal in all living organisms. Historically, viruses have been responsible for significant public health crises, socioeconomic challenges, and environmental disruptions (Sankaran & Weiss, 2021). SARS-CoV-2, commonly known as COVID-19, has resulted in a confirmed death toll of 7.1 million as of November 2024 (WHO, 2024), triggered widespread lockdowns, and led to a global economic recession (World Bank, 2022). Interestingly, the pandemic also had temporary yet beneficial effects on the environment (Ang et al., 2023). Despite their harmful effects, viruses influence ecosystems, evolution, and even human health in ways that are not entirely detrimental (Pan et al., 2019). Viruses, for instance, regulate microbial populations, contribute to genetic diversity, and even play essential roles in modern medicine, such as gene therapy and oncolytic cancer treatments (Liu et al., 2023; Mietzsch & Agbandje-McKenna, 2017).

The *Pokémon* universe introduces a unique perspective on infectious agents through the Pokérus (PKRS), a pathogen that infects Pokémon. This world is home to a diverse array of creatures that resemble real-life animals, plants, and even inanimate objects. Pokémon are categorized based on biology into elemental types, such as Water or Grass, and abstract types like Psychic or Ghost. Regardless of their type, all Pokémon are susceptible to infection by PKRS, a multi-host virus.

Unlike most multi-host viruses, which experience fitness trade-offs due to differential gene effects across hosts, PKRS faces no such limitations (Elena et al., 2009). It is the only known infectious agent in *Pokémon*, with no competitors or resistant hosts. This lack of ecological constraints allows PKRS to bypass the typical evolutionary pressures that affect real-world viruses.

Remarkably, the adverse effects of PKRS are minimal compared to its benefits, as it significantly enhances Pokémon growth and development, making PKRS a mutualistic virus as well. Mutualistic viruses might show three different positive effects on a host's fitness: protection, invasion, and, like in the case of PKRS, development (Pradeu, 2019). Viral-enhanced development is the result of co-evolution between the virus and its host (Pradeu, 2019). Viruses also enhance the host's fitness through the activation of their immune system, whether through immunological memory or immunotherapies (Welsh et al., 2004; Lin et al., 2023). Regardless of the mechanism, PKRS biology remains a mystery; however, it offers a valuable opportunity to examine mu-

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tualistic viral interactions through a fictional lens. By comparing PKRSs with real-world immunological and evolutionary processes, we aim to explore how an infectious agent could plausibly enhance host development. In doing so, this analysis not only deepens our understanding of viral-host dynamics but also challenges the conventional view of viruses as purely pathogenic.

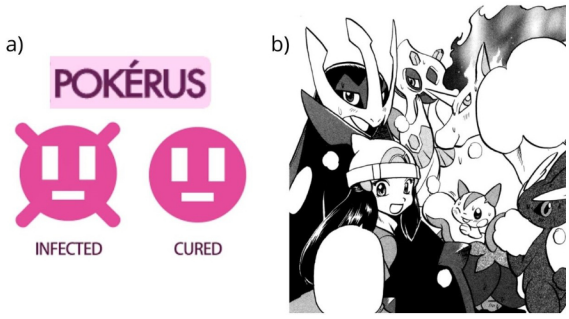

Figure 1. Pokérus manifestations. a. In the video game, PKRS is represented in the info card of an infected Pokémon with the word "Pokérus" or the "infected" symbol. If the Pokémon is cured, it shows the "cured" symbol. B. In the manga, PKRS-infected Pokémon show symptoms of fever, rubor, and exhaustion. Images were extracted from Bulbapedia (https://bulbapedia.bulbagarden.net).

ETIOLOGY AND PATHOLOGY OF PKRS

PKRS is a microscopic life-form that infects all Pokémon and spreads through direct contact between an infected and a healthy Pokémon, including eggs, within the same party. The infection lasts between one and four days, depending on the strain. Little is known about PKRS symptoms. In the video games, the infection appears asymptomatic, with affected Pokémon displaying only an icon on their info card (Fig. 1a). In the manga, however, infected Pokémon exhibit fever-like symptoms, such as sweating and facial rubor (Fig. 1b). This variability mirrors real-world infections like Influenza and COVID-19, which can range from asymptomatic cases to severe illness, though unlike these diseases, PKRS is never fatal (Shaikh et al., 2023).

Notably, PKRS resolves naturally, unaffected by external factors such as Pokémon Centers or healing items. Once cured, the Pokémon's info card updates to reflect its non-infectious status, it can no longer spread the virus and becomes immune to it (Fig. 1a). Yet, despite being immune to reinfection, it retains the long-term benefits of having been infected. This suggests that while the active virus is eliminated, some component persists—most likely as a provirus or episome, a viral genetic sequence that remains in the host. These sequences could sustain the enhanced EV production observed after recovery. In the following section, we will explore how PKRS influences a Pokémon's development.

POKÉMON DEVELOPMENT AND HOW IT IS AFFECTED BY PKRS

Like all living beings, Pokémon possess unique genetic-like traits set at birth that determine their individual characteristics. These traits, known as Individual Values (IVs), influence the magnitude of a Pokémon's stats, including attack power, defensive resilience, speed, and stamina in battle. IVs range from 0 to 31, meaning that a Pikachu with 31 IVs in Attack will deal significantly more damage than a Pikachu with 0 IVs in Attack, assuming they are at the same level.

A Pokémon's development is primarily measured in two ways: through its evolutionary progression or by its level. Unlike real-world evolutionary biology, evolution in *Pokémon* is not a gradual process of adaptation; instead, it involves an abrupt metamorphosis into a stronger form while retaining essential traits from its evolutionary line (Fig. 2a); however, not all Pokémon evolve, which makes level progression their main indicator of strength (Fig. 2b). A Pokémon's level increases as it gains experience from battles, thereby improving its overall stats and combat potential. As in most role-playing video games (RPGs), defeating Pokémon grants experience, and crossing a

certain threshold increases the Pokémon's level.

Nonetheless, defeating a Pokémon grants not only experience but also Effort Values (EVs), which enhance a Pokémon's stats beyond its IVs baseline, complementing the leveling-up process. EVs are points that function similarly to epigenetic modifications, amplifying specific attributes regardless of a Pokémon's innate IVs. This dynamic adjustment allows trained Pokémon to surpass their untrained counterparts, even if they share identical IVs. Pokémon, however, are limited to a total of 510 EVs across all stats, with a maximum of 252 EVs allocated to any single stat. This means that a Greninja with 31 IVs and 0 EVs in Attack will deal less damage than a fully trained Greninja with 31 IVs and 252 EVs in Attack.

Figure 2. Evolutionary and non-evolutionary paths in Pokémon development. a. An evolutionary line showcasing the three stages of Piplup's development (from left to right: Prinplup, Piplup, and Empoleon). B. Sableye, a species that does not undergo evolution, representing a static developmental trajectory where level progression is the primary indicator of growth. Images were extracted from Bulbapedia (https://bulbapedia.bulbagarden.net).

Each Pokémon, when defeated, grants a specific number of EVs to one or multiple stats, with yields ranging from one to three points. To illustrate, defeating a Weedle provides 1 EV in Speed, while a Gengar grants 3 EVs in Special Attack (Fig. 3). Understanding which Pokémon yield specific EVs is essential for optimizing a Pokémon's training and maximizing its potential in battle.

This is where PKRS comes into play. A Pokémon infected with PKRS, or a cured one, gains twice the usual amount of EVs from defeated opponents, significantly reducing training time by half. Using the previous example, a Weedle that normally grants 1 EV in Speed will instead provide 2 EVs to an infected Pokémon, while a Gengar will yield 6 EVs in Special Attack instead of 3 (Fig. 3). For this reason, PKRS is considered a mutualistic virus that speeds up the development of a Pokémon instead of being detrimental. Yet, if PKRS is such a beneficial mutualistic virus, why is it only temporary? And if it enhances a Pokémon's growth, what evolutionary advantage does PKRS itself gain from this interaction? These questions, and more, will be approached in the next section.

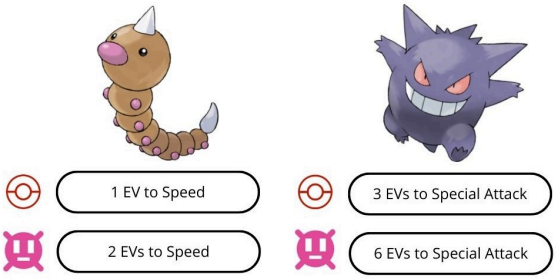

Figure 3. PKRS doubles Effort Value (EV) yields in infected Pokémon. Defeating a Weedle normally yields 1 Speed EV, but 2 if the Pokémon is infected with PKRS. Similarly, defeating a Gengar provides 3 Special Attack EVs, which are doubled to 6 in the presence of PKRS. The icons represent a normal Pokémon (red Poké Ball) and a PKRS-infected one (pink virus symbol). Official artwork for both Weedle and Gengar (©Nintendo/Game Freak, 1995–2025).

PHYSIOLOGICAL AND EVOLUTIONARY MECHANISMS OF PKRS

While the effects of PKRS are well-documented in video games, its underlying biological mechanisms remain a mystery. This raises several key questions regarding its nature and function. (1) PKRS enhances EV gain, but what exactly are EVs from a biological standpoint? (2) If the virus establishes a mutualistic relationship with Pokémon, what benefits does each party gain? (3) Furthermore, if PKRS provides such an advantage, why do Pokémon eventually

eliminate it from their system? (4) Finally, what molecular and physiological mechanisms does PKRS trigger to amplify EV accumulation? By examining examples from real-world viruses, we can begin to uncover possible explanations for these intriguing dynamics.

BIOLOGICALLY, WHAT ARE EVs?

As previously discussed, EVs are acquired by defeating opposing Pokémon, and a PKRS-infected Pokémon doubles the rate at which it gains EVs. Pokémon, however, can also obtain EVs through another method that provides further insight into their nature: the consumption of vitamins. In the *Pokémon* world, "vitamins" refer to items that enhance a Pokémon's stats. These include HP Up, Zinc, Iron, Carbos, Protein, and Calcium—none of which are true vitamins but rather a combination of macro and micronutrients.

This suggests that EVs are not merely absorbed from defeated Pokémon but are instead naturally produced during training. Thus, these vitamins may serve as cofactors that enhance the EV generation process. Indeed, the intake of macro and micronutrients is not only essential for overall health but also plays a crucial role in boosting physical performance (Beck et al., 2021; Ormsbee et al., 2014). Since EVs are produced during physical activity, they may share functional similarities with myokines and exerkines—molecular signals released during exercise that enhance cardiovascular, muscular, and immune health (Chow et al., 2022; Leal et al., 2018).

Moreover, micronutrients are crucial for the function of myokines and exerkines, further linking dietary intake to the heightened production of EVs. For example, decorin, a small pro-myogenic myokine, inactivates the muscle-growth inhibitor Myostatin (MSTN) in a zinc-dependent manner (Lee & Jun, 2019). Likewise, osteonectin, a calcium-binding myokine, is constitutively expressed in mineralized tissues, playing a role in bone formation, cellular processes, and regulation of metal ions and growth factors (Robey, 2008). Given these parallels, EVs may serve as developmental enhancers through physical training, a process further amplified by dietary supplementation.

WHAT DOES PKRS GAIN FROM THIS STRATEGIC SYMBIOSIS?

To fully understand the PKRS-Pokémon relationship, we must also consider the benefits PKRS gain from infecting a host. As a virus, PKRS can be considered a genetic parasite, relying on host cells to replicate and spread its genetic material (Taylor, 2014). Since PKRS is transmitted exclusively during battles, we can infer that direct contact between Pokémon is required for infection. In virology, direct transmission includes skin-to-skin contact, airborne droplets, and bloodborne pathways, among others (Taylor, 2014). Although Pokémon are occasionally depicted with injuries, bleeding is not a recognized game mechanic. Thus, it is reasonable to narrow PKRS transmission to airborne and skin contact mechanisms during the physical exchanges of battle. We can narrow it further if we consider that not all attacks make physical contact, leaving us with only airborne transmission.

Once the mode of transmission is clarified, we can return to the original question: What does PKRS gain from infecting a Pokémon? The most straightforward answer is that it replicates within the host and then transmits to another Pokémon to perpetuate its life cycle. However, a deeper question arises: What does PKRS gain from making the infected Pokémon stronger? The answer likely ties back to its ultimate goal: increasing the chances of transmitting PKRS to another host. But how does making a Pokémon stronger contribute to this process?

Considering all our conjectures, we know that PKRS accelerates the training process. Since it only remains active within a host for up to four days, we can hypothesize that an infected Pokémon becomes

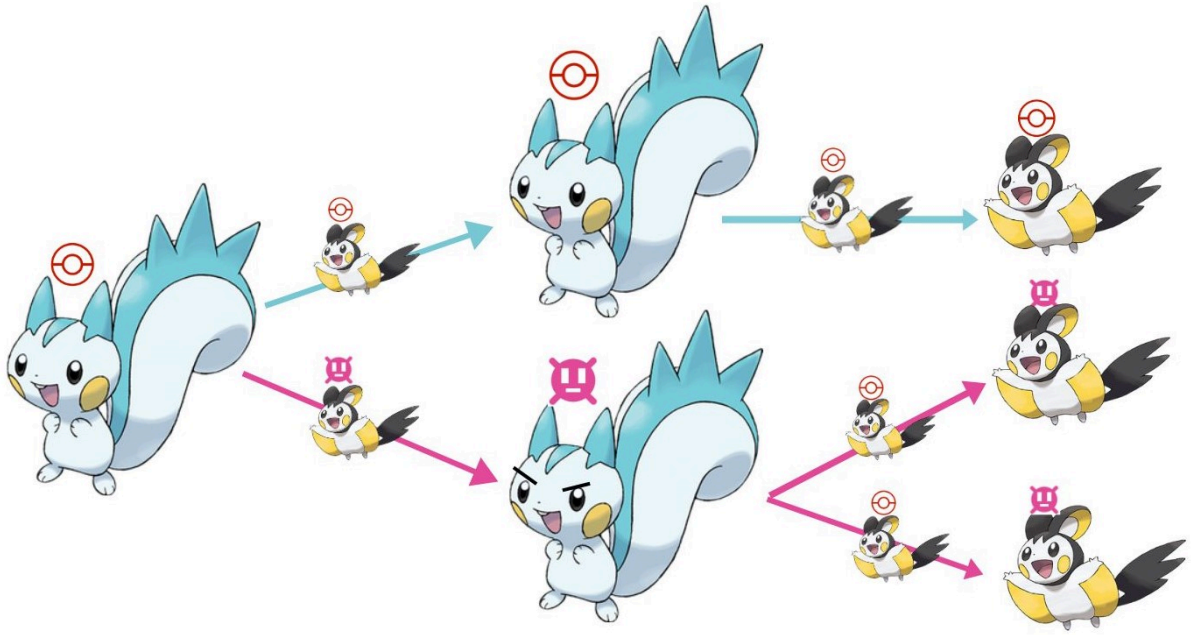

Figure 4. Model of PKRS propagation. Blue arrows illustrate a non-contagious scenario in which a healthy Pachirisu repeatedly battles uninfected Emolga without contracting PKRS. In contrast, pink arrows represent a contagious pathway: Pachirisu battles a PKRS-infected Emolga, contracts the virus, and subsequently displays increased battle frequency compared to its uninfected counterpart. This behavioral shift leads to an accelerated rate of viral transmission. The icons represent a normal Pokémon (red Poké Ball) and a PKRS-infected one (pink virus symbol). Official artwork of Pachirisu and Emolga (©Nintendo/Game Freak, 1995–2025).

more inclined to battle during this window, having grown stronger in that short period. This increased battle engagement would, in turn, enhance the chances of PKRS transmission (Fig. 4). Interestingly, this idea is not without precedent in the biological world. Several viruses are known to alter their host's behavior or have short windows of high transmissibility. For example, the rabies virus (RBVM) is a fatal neurotropic virus that causes rabies in mammals. Neurological symptoms include delirium and aggressive behavior, which often render infected individuals erratic and violent (Khairullah et al., 2023). Since rabies spreads through bites, these behavioral changes significantly increase the likelihood of viral transmission (Fisher et al., 2018). PKRS does not appear to alter a Pokémon's behavior drastically. Still, it likely increases the Pokémon's impetus to engage in battle, thereby enhancing the chances of spreading the virus to more opponents. On the other hand, a real-world example of a short-lived, directly transmitted virus is the severe case of the Ebola virus (EBOV). EBOV is the etiological agent of Ebola virus disease (EVD), which is characterized by significant fluid loss and internal bleeding, typically progressing over a period of 2 to 20 days, with 10 days being most common (Feldmann et al., 2020). Transmission occurs through direct contact with contaminated bodily fluids, including blood, saliva, and sweat (Vetter et al., 2016). While PKRS symptoms are far less severe, the inferred mode of transmission shares similarities. In conclusion, given that Pokémon battles involve close contact and intense exertion, we propose that PKRS is transmitted via airborne microdroplets—such as sweat or saliva—released during these interactions.

WHY DO POKÉMON OVERCOME PKRS IF IT MAKES THEM STRONGER?

If PKRS is so beneficial to Pokémon, why hasn't it become a permanent feature of their biology—perhaps even integrated into

the Pokémon's genome over time? Processes such as endogenization could allow PKRS to integrate with the host's DNA. A good example of this process is found in parasitoid wasps, which inject their eggs into a host along with virus-like structures produced from endogenous viral elements (EVEs) (Guinet et al., 2023). These viral elements help dampen the host's immune system, facilitating the development of the insect (Guinet et al., 2023). A closer example can be seen in Syncytin-1, a protein that developed from endogenous retroviruses and is essential for forming the syncytiotrophoblast, a tissue that separates maternal and fetal bloodstreams in the placenta (Chuong, 2018). However, for this process of viral domestication to occur, two key factors are required: a long time span and persistent selection pressure (Holmes, 2008).

Interestingly, PKRS is absent in the Pokémon Legends: Arceus game, which is set in a distant past (approximately 200 years ago). This suggests that PKRS is a relatively recent viral emergence, not yet present in earlier Pokémon populations. As such, the necessary evolutionary time for integration or co-evolution has likely not occurred.

Another potential explanation is immunological tolerance. If PKRS were so beneficial, perhaps the immune system would allow it to persist, similar to how the gut microbiota maintains a balanced relationship with the immune system (Shao et al., 2023). However, this does not seem to be the case. Once the four-day infection period ends, the host gains immunity and becomes resistant to reinfection. This indicates the presence of immunological memory and suggests that PKRS is ultimately cleared by the host's immune system.

So, why does this happen? One possibility is that while PKRS is beneficial in the short term, it may pose long-term risks. If an infected Pokémon is more inclined to battle, this could lead to overexertion (Fig. 5). Constant and prolonged physical exertion could result in conditions such as Overtraining Syndrome (OTS) or Exertional Rhabdomyolysis (ER) (Kreher & Schwartz, 2012). While OTS generally leads to fatigue and performance decline, ER is particularly dangerous, causing skeletal muscle damage and necrosis that can lead to multiple organ dysfunction (Yang et al., 2025). This constant strain could overwhelm the Pokémon's body, triggering an immune response to eliminate the virus before the damage becomes irreversible.

Ultimately, the Pokémon's immune system clears the virus, but the enhanced EV production persists, allowing the Pokémon to retain the short-term advantages of PKRS without the associated risks. In this way, PKRS might enhance the Pokémon's battle capabilities for a limited period, but its potential for overexertion necessitates the virus being expelled before significant harm can occur.

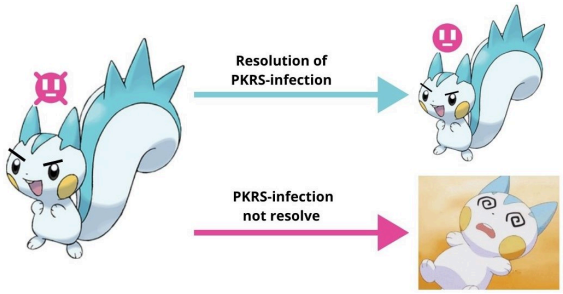

Figure 5. Divergent outcomes of Pokérus infection. The blue arrow represents a favorable outcome in which Pachirisu recovers from PKRS while retaining its associated benefits. In contrast, the pink arrow illustrates a negative outcome in which unresolved PKRS infection leads to overexertion and potential health detriments for Pachirisu. The icons indicate infection status: the pink virus symbol for an infected state, and the pink face symbol for a cured state. Official artwork of Pachirisu (©Nintendo/Game Freak, 1995–2025).

SO, HOW DOES PKRS BOOST EV PRODUCTION?

Finally, let's discuss the mechanisms behind the overproduction of EVs by PKRS. Since Pokémon naturally produce EVs, it's reasonable to infer that enzymatic processes are involved. Let's call the hypothetical enzyme responsible for this process 'EVase'.

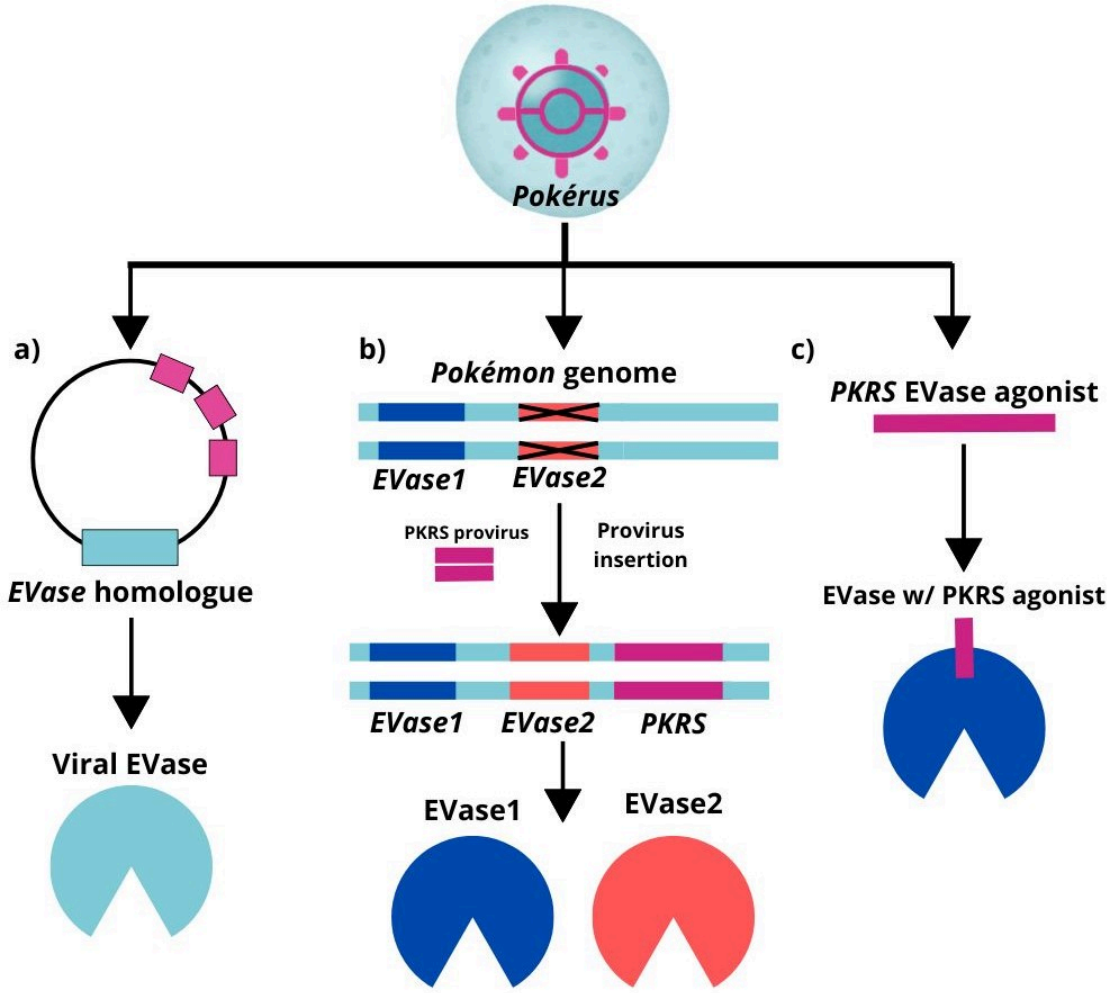

Figure 6. Hypothetical mechanisms of Pokérus-induced EV production. Following PKRS infection, several mechanisms could explain the enhanced production of effort values (EVs): a. PKRS may encode an EVase homolog that directly increases EV output upon expression. b. the virus might integrate into the host genome as a provirus, up-regulating endogenous EVase-related genes and boosting EV production from different sources. c. PKRS could secrete an EVase agonist that stimulates increased EV synthesis.

Thus, PKRS must be influencing EVase activity in some capacity—either by increasing its production, enhancing its function, or both. Several plausible mechanisms could explain this interaction involving genetic and molecular strategies.

To begin with, PKRS could possess oncovirus-like traits, including gene activation, genomic instability, and the production of host-homologue proteins (Mui et al., 2017). First, PKRS might encode an EVase-like homologue, thereby enhancing EV production (Fig. 6a). A relevant example is the Epstein-Barr virus (EBV), which encodes latent membrane protein 1 (LMP1)—a homologue of tumor necrosis factor (TNF) (Cameron et al., 2008). LMP1 mimics TNF's function by activating intracellular pathways such as NF-κB, contributing to the virus's oncogenic potential (Cameron et al., 2008).

A second possibility is that PKRS genome insertion activates EVase-related genes, such as secondary copies or other members of the EVase protein family (Fig. 6b). This mechanism resembles insertional mutagenesis seen in retroviruses like Murine leukemia virus (MuLV), which fre-

quently integrates near the host proto-oncogene *myc*, leading to its activation and the onset of neoplasia (van Lohuizen et al., 1989).

A third and final possibility is that PKRS produces an agonist—a molecule that directly enhances the function of EVase (Figure 6c). Rather than altering gene expression, PKRS could synthesize a viral protein or RNA that binds to EVase, stabilizing it or increasing its catalytic efficiency. A compelling precedent can be found in the influenza virus, which generates aberrant mini viral RNAs (mvRNAs) that act as agonists for the host immune receptor RIG-I, triggering an antiviral response via interferon-β production (Te Velthuis et al., 2018).

Altogether, these mechanisms illustrate the diverse strategies PKRS might employ to enhance EV production, ranging from encoding viral homologues to manipulating host gene expression and enzyme activity. While each hypothesis draws from well-established viral behaviors, they remain speculative in the context of PKRS. Nonetheless, they offer a compelling framework to understand how a seemingly benign virus could permanently alter a host's physiology for enhanced development.

CONCLUSION

PKRS is a multi-host virus capable of infecting every known Pokémon species. While it may cause mild symptoms, its overall benefits to Pokémon's growth and development far outweigh any detrimental effects. Despite its in-game simplicity, little is known about the virus's biology, leaving us to speculate on its physiological and evolutionary mechanisms. Notably, PKRS enhances EV production during training, though only for about four days. This limited timeframe suggests that the host immune system effectively clears the virus, subsequently establishing immunity. Its spreading strategy may involve temporarily boosting the host's performance, thereby increasing encounters with other healthy Pokémon and facilitating transmission. Lastly, PKRS could boost EV production through molecular mechanisms such as the activation of EVase-related genes, the expression of EVase-homologue proteins, or the synthesis of EVase agonists. Understanding PKRS may not only reveal the secrets of this beneficial infection but also offer broader insights into host-virus coevolution and enhancement.

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Wilted lands and wounded worlds: visualizing environmental costs of war in Hayao Miyazaki's *Nausicaä of the Valley of the Wind*

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Past studies on *Nausicaä of the Valley of the Wind* (風の谷のナウシカ; Topcraft, 1984) have primarily focused on its ecological themes and anti-war messages through analysis of the narrative as a whole or Nausicaä's character. These studies address the ethical and environmental consequences of war shown through the dystopian nature of the film's setting and its religious symbolism. However, I have seen almost no research on how visual storytelling contributes to these messages.

This paper addresses how the visual representation of the environmental consequences of war in *Nausicaä of the Valley of the Wind* can impact our views of those issues in our world. The paper will show that the visuals in the film are not simply aesthetic decisions, but a crucial narrative device to convey the effects of war on both people and nature.

Therefore, this paper explores how Miyazaki uses elements of mise-en-scène such as color, lighting, body language and other visual storytelling elements to communicate and add emphasis to the anti-war messaging of the film; especially those that display both the ecological and human consequences of war. I argue that the film's use of visuals not only supports the anti-war themes of the film as a whole but also adds a stronger emotional and moral weight to the story by reflecting real-life war technologies in its visuals. This allowed audiences to reflect on real-life issues regarding the environmental and human consequences of warfare. In this way, the film created a bridge between fantasy and reality, urging its viewers to strive for a more peaceful and environmentally conscious world.

BACKGROUND

Animated films, like many other art forms, can convey so much emotion and be filled to the brim with meaningful messages and ideas. Especially with animation, the director is able to display a myriad of stunning visuals that can be impossible to recreate in live action film. Throughout history we as humans have used storytelling and art to reflect on and understand the world and the current issues we face. With the state of our world being as it is, with conflict at every corner, with global warming and other environmental issues being more pressing matters than ever before, it is clear that the environmental messages in *Nausicaä* are of the utmost importance to our society today. This is why it is important to ask, how can the depiction of the environmental impact of war in this film help us change our view of and approach to these issues in real life?

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Hayao Miyazaki's 1984 film *Nausicaä of the Valley of the Wind* follows the pacifistic and kindhearted princess of the Valley of the Wind as she navigates the apocalyptic landscape of the film, searching for a way to undo the damage caused by the wars of the past and prevent further damage in the present. Miyazaki's filmography as a whole contains many important messages regarding the way in which humans interact with and affect the natural world. His films, including *Nausicaä*, focus on the relationships between humans and animals, exploring the imbalance between the human and natural worlds. With *Nausicaä* being the only film directed by Miyazaki that depicts a more modern style of warfare, this film could help to open people's eyes to the damage war puts not just on the humans involved but on the environment which we all share.

Nausicaä of the Valley of the Wind was originally a manga of the same name that Hayao Miyazaki wrote for Animage, with it being released from February 1982 to March 1994. It saw great success amongst Japanese readers through its run. This prompted the manga's adaptation into an animated film which was directed by Miyazaki and released to Japanese audiences in 1984. Due to the extreme inconsistencies between the original film and Showmen Inc.'s English dub of *Nausicaä* – renamed *Warriors of the Wind*– Miyazaki considered never releasing his films to foreign audiences again. This dub had changed the names of most characters, cut nearly 30 minutes off of the film and completely altered its message. Later, a deal was made between Studio Ghibli and Walt Disney Studios Home Entertainment, and Miayzaki allowed them to dub his films under the condition that they make no cuts and keep the original meaning intact (Cinematheque, 2016). Because of this, Disney's English dub will be the main focus of this paper (Walt Disney Studios Home Entertainment, 1985).

KEYWORDS & TERMS

For the purpose of this article, when referring to the natural world it would more specifically be described as the surrounding elements that are essential for the well-be-

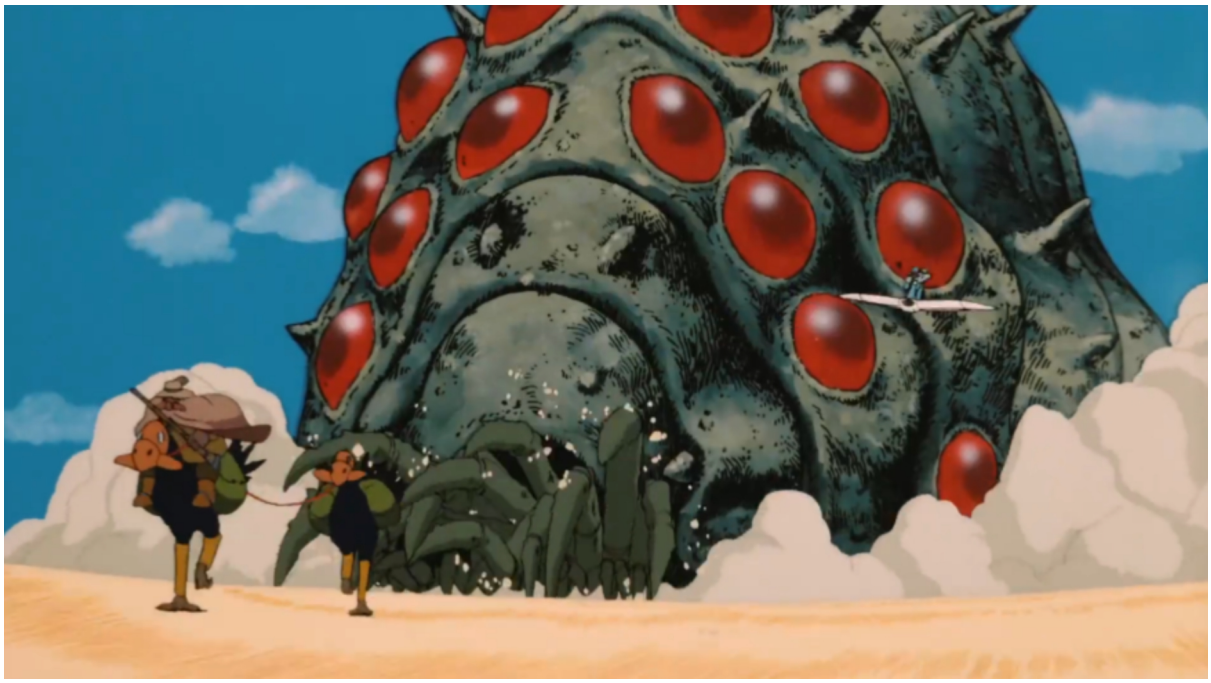

Figure 1. Lord Yupa (left), riding on an emu-like animal, running away from the chasing ohmu. Screen capture from the film.

Figure 2. Giant warriors walking through a city in flames. Screen capture from the film.

ing of both human and non-human life which includes green spaces, wildlife habitats, biodiversity and clean air, water and soil. Additionally, there are several terms which one who has not watched the film would not be able to understand, and these terms are as follows.

The ohmu (Fig. 1) are enormous, powerful and intelligent pill bug-like animals which are feared by the people in the film due to the fact that they could be considered the kings of the toxic jungle.

The Toxic Jungle is a vast forest where the air, water, soil and plants are poisonous to all but the giant arthropods which inhabit it. The toxic jungle only became so poisonous after the Giant Warriors were used in the last days of the Ceramic War. The Giant Warriors (Fig. 2) are giant, biomechanical lifeforms which are treated, and act, more as weapons rather than as independent beings.

The Ceramic War is an apocalyptic war that occurred 1000 years before the events of the film in what was called the Ceramic Period, which destroyed civilization, caused an ecocide and created the vast Toxic Jungle during the Seven Days of Fire. The Seven Days of Fire was a seven-day period at the end of the Ceramic War in which the Giant Warriors were deployed.

LITERATURE REVIEW

When analyzing Miyazaki's films, including *Nausicaä of the Valley of the Wind*, often the messages regarding warfare's effects on the natural world focus more on the direct impacts rather than the indirect ones. Additionally, many researchers look at the film from a spiritual lens with DeWeese-Boyd (2009) believing Nausicaä serves as a Christ-like figure, while both Morgan (2015) and Nunes (2021) believe that Nausicaä serves as an example of how to restore balance between humans and nature. Despite that, these authors see her role in restoring balance differently. Nunes believes that Nausicaä gave herself to nature, sacrificing her free will in order to heal the earth without personal bias. On the other hand, Morgan believes that she serves as an example of how the fragmentation between the mind, body, spirit and nature can be re-

stored through respect and care for the natural world.

In addition to this, there are some researchers who believe that *Nausicaä* can be used as a teaching tool, with Kleese (2024) believing that, since the film is not directly associated with any singular real-life issue but with many different events and issues, it can be used in classrooms to help children understand the importance of nature and finding a democratic solution to both environmental and political issues in a more digestible way.

It is no wonder the previous research on *Nausicaä* has such a spiritual focus, as Miyazaki's filmography as a whole often focuses on the relationship and imbalance between humans and the natural world in a very spiritual manner. However, *Nausicaä* not only explores the direct impacts of war and other human activities, but also their indirect ramifications. Thus, this paper will hopefully fill a gap in the existing *Nausicäa* literature by analyzing the film's messages regarding warfare's indirect effects on the environment and how this exercise can give us insight to our real-world problems.

The importance of the environment

Climate change and other environmental crises such as soil and water contamination are all issues which have been recognized as important by the public eye. From everyday people to those in important positions, most can agree that the health of the natural world is important to the health and survival of life on earth. As UN Secretary-General António Guterres said at the biodiversity COP in Montreal 2022, "Without nature, we have nothing" (Abbasi et al., 2023). Access to clean water is undeniably fundamental to life on Earth, be it human or not. Even with this being common knowledge, pollution has damaged water quality to a point where it is causing a rise in waterborne diseases and damaging the health of both freshwater and saltwater ecosystems (Abbasi et al., 2023). Additionally, the rising temperatures, extreme weather events, air pollution and the heightened spread of infectious diseases are just a few examples of major health issues exacerbated by climate change (Abbasi et al., 2023). As the human population grows, we see that demands on Earth's ecosystems are becoming more unsustainable; with the way that we currently treat our environment, long-term human and non-human security are clearly at stake (dos Santos, 2024).

The importance of war

The ever-worsening health of our natural world impacts us in many ways. Land degradation and other environmental issues which may cause an area to be less habitable can lead to the disruption of social and economic systems. Shortages of land, shelter, food and water exacerbate poverty and the poor living conditions in many areas of the world (Anonymous, 2004), this in turn leads to mass migration and conflict over usable land and resources necessary for life (Abbasi et al., 2023). While the degradation of land can in itself cause wars to erupt between peoples disputing over the usable land, war can and has caused additional land degradation. In Afghanistan, for example, forests have been leveled and its land and farmlands polluted from the years of use of fuel, chemicals and mines during wartime (Bonds, 2015).

Certain practices of war have more devastating impacts on the longevity of our natural world. One poignant example of how destructive war can be to our planet can be seen in the burning of Kuwaiti oil wells that took place during the The Gulf War as a part of their scorched earth tactics. This resulted both in the soil becoming contaminated with excessive amounts of hydrocarbons and heavy metals and in the release of massive amounts of particulate matter and other pollutants into the atmosphere (Aldawsari, 2024).

The importance of film

Everything from the way a shot is framed to the smallest detail captured within the shot can have an effect on the viewers of a film. Displaying intense emo-

tional imagery has been proven to have significant psychological effects on viewers. For instance, the Kuleshov effect is a famous example of how film influences viewers' emotional perception; it has shown that point-of-view editing practices influence viewers' emotional interpretation of neutral facial expressions in a face-scene-face sequence (Cao et al., 2024). With this in mind it is evident that the things that films show their viewers can and do impact how they view the world.

At the same, time films utilize the elements of mise-en-scène to convey messages to their audience. Mise-en-scène is a French term meaning what is put into a scene or frame and consists of all the visual information in front of the camera (Caprio, 2021). Understanding these elements may help understand what the director of a film wants to convey with any given scene and understand how the visuals impact the audience.

Why anime?

All forms of filmography are capable of affecting their audiences with the previously mentioned methods. However, animation is often able to employ visuals and different types of shots which can often be extremely difficult or expensive to replicate in live action film. Because of this and because animated films in the West are often avoidant of more serious topics, seeing as they are viewed as being only for small children, that Japanese animation, or anime, can be an immensely powerful and impactful type of filmmaking. Several studies have shown that anime can influence its audience and evoke positive changes in them (e.g., Yusof et al., 2024). With the unique perspective that anime provides, which is more provocative, tragic and contains far more complicated storylines than the ones seen in American popular cinema, anime has proven itself to be a tool for understanding the complex human–environment relationship and environmental problems (Mumcu & Yılmaz, 2018).

Why Miyazaki?

Within the anime community Hayao Miyazaki has carved out an image for himself as a masterful director who is skilled in creating both enchanting fantasies and incredibly thought-provoking films (Mumcu & Yılmaz, 2018). He is quite well renowned for his beautiful landscapes, heavy ecological themes and overall beautiful and touching storytelling. Several of his films such as *Princess Mononoke*, *Nausicaä of the Valley of the Wind* and even *Ponyo* feature themes of ecological imbalance as the main plot points of the films. Even those which do not have these themes quite as ingrained in the plot still have some commentary on the matter or feature more lighthearted takes on nature's relationship with humanity. This can be seen in the stories of *Spirited Away* and *My Neighbor Totoro*. Additionally, many of his films also approach themes of war and conflict, such as *Princess Mononoke*, *Nausicaä of the Valley of the Wind*, *Porco Rosso*, *Castle in the Sky*, *Howl's Moving Castle* and *The Wind Rises*. This leaves only six of his fifteen films, all of which have seen great success, with no themes of interest to this paper. For this reason, it is evident that Miyazaki is a perfect choice for the subject matter of this paper.

Why *Nausicaä*?

With only six of the fifteen films Miyazaki has directed or written having no themes of interest to this paper, one may wonder what it is that makes *Nausicaä* more suitable than any of his other films. Well, though many of his films touch on environmental issues with Miyazaki even going as far as saying "I've come to a point where I just can't make a movie without addressing the problem of humanity as part of an ecosystem" in an interview with Asia Pulse, May 16, 1997, not many of his films include war in the main storyline. Only five do, as mentioned above. There are only two films, *Nausicaä* and *Princess Mononoke*, that cover both environmental issues and war. The major factor which puts *Nausicaä* over *Princess Mononoke* is the setting; *Princess Mononoke* is set in Japan's late Muromachi

Period, which was characterized by rapid industrialization and frequent conflicts. On the other hand, *Nausicaä* is set in the post-apocalyptic future which bears much resemblance to our world, with some current technologies such as guns, grenades and tanks being included, as well as fictitious technologies which closely mirror real-life technologies (e.g., how the Giant Warriors function similarly to nuclear bombs).

METHODOLOGY

As previously stated, the Kuleshov effect demonstrates that intense visuals can alter one's interpretation of the world and this in itself proves that analysis via the elements of mise-en-scène is a viable method for breaking down *Nausicaä* with the purpose of determining how the visual depiction of the environmental impact of war can affect our view of and approach to these issues in real life. However, this isn't the only reason mise-en-scène analysis was used within this study, since it has been used for teaching aspiring filmmakers how films communicate messages with visuals; as my question focuses on visual depictions in film, mise-en-scène analysis was perfectly suited for my project. The elements of mise-en-scène are as follows: settings and props, costume, hair and makeup, facial expressions and body language, lighting and color and lastly positioning. Each of the 38 scenes of the film were analyzed to see how these elements are utilized and what effect it can have on the audience.

FINDINGS

Throughout the film the elements of mise-en-scène can be seen in use in many ways. Despite the subtle differences in the amount each element is used in the different parts of the story, the overall message urges viewers to rethink their stance on warfare and its technologies, not just for the impact it directly has on humans, but also for the sake of the natural world.

Figure 3. Images of the tapestry shown in the opening credits. Source: Miyazaki (2019); reproduced under fair use.

War technologies

One example of how body language, facial expressions and color are used to push the film's message regarding the use of war technologies can be perfectly seen in the opening credits, which appear in scene two directly after the narrator introduces the world reading aloud the words that can be seen in figure one that state "One thousand years have passed since the collapse of industrialized civilization. The Toxic Jungle now spreads, threatening the survival of the last of the human race." Right after this is read as the credits roll a tapestry is panned over, shown in Figure 3.

The tapestry shows how the creation of the Giant Warriors led to the creation of the Toxic Jungle and the fall of humanity. Within this tapestry, while in the process of building the warriors they appear confident in their body language and facial expressions, they are clearly calm and all is well. However, the colors of the warrior are bright and clash with that of the people which are more muted browns rather than the bright blues reds and yellows of the warrior. This itself already sets up for the destructive and overpowering nature of the Giant Warriors before they have even been finished and this is only confirmed when they are soon after in the tapestry shown wreaking havoc on the very same people who created them. In contrast to their poised expression and way of holding themselves previously in the tapestry, here they appear to be in great distress and panic. While this on its own is a striking visual representation of how dangerous technologies can be, even to their own creators, these visuals are given new meaning when we see the Giant Warriors in actual use towards the end of the film.

The audience was shown the similarities between the Giant Warriors and nuclear bombs in several instances towards the end of the film; in particular, there is one which really drives home the parallels between them (Figs. 4 and 5). In this scene, the Giant Warrior is being used by the main antagonist, its form being completely fictional and bearing no resemblance to real-life technologies, with the warrior shooting a beam of light from its mouth. The explosion that this caused very closely resembles the mushroom shape of nuclear bombs. Other aspects of this scene that help to draw simi-

Figure 4. Giant warrior falling apart while charging up to fire. Screen capture from the film.

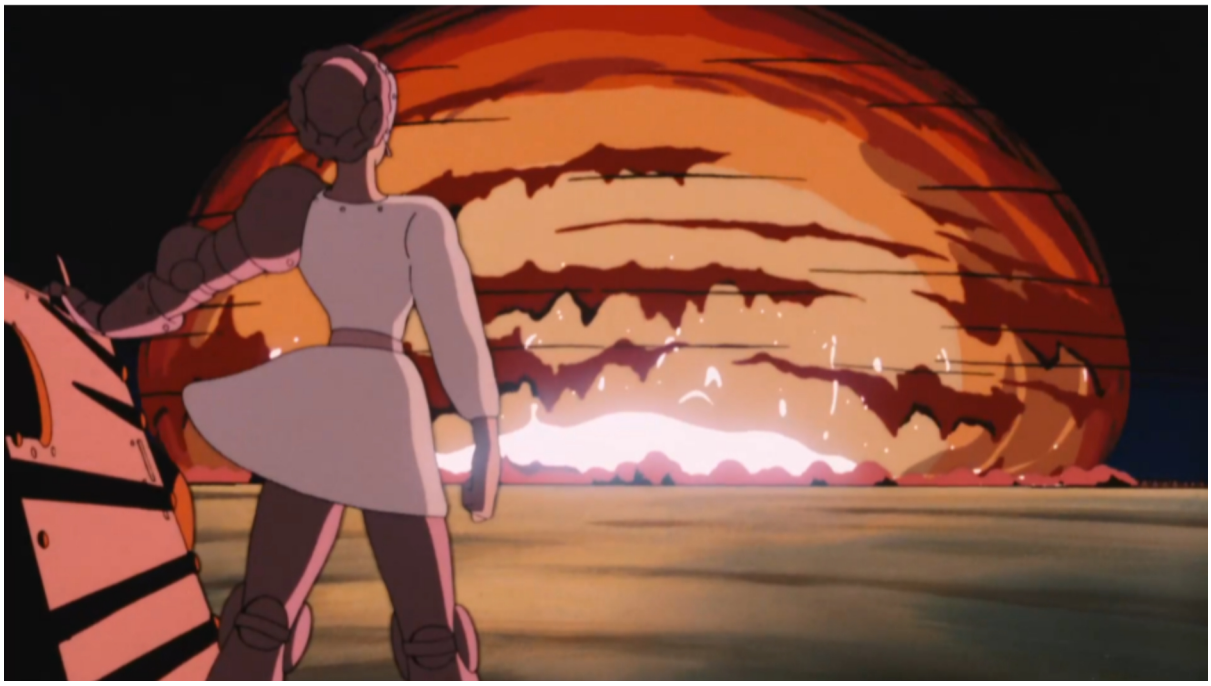

Figure 5. Kushana (left) looking out towards the blast caused by the giant warrior. Screen capture from the film.

larities between this fictional tool of destruction and the very real nuclear weapons we have, such as the fact that before it dies the warrior only sets off two explosions. This could be a reflection of the fact that these technologies have only seen practical use twice, once in Hiroshima and once in Nagasaki. While these parallels alone drive a case for the film's anti-war messaging, other elements regarding the Giant Warriors in other scenes help to push this narrative as well.

Every scene which has the Giant Warrior in it, from the beginning to the end of the film, is decisively negative. Around the middle of the film there is a scene where the warrior is in a sort of incubation. The film explains that the warrior needs time to develop before it is able to be used as a war machine and walk on its own. The warrior is depicted within this scene with its colors being both muddy and bloody, with the lighting highlighting not only its strange shape but also how slimy it appears. This all helps to show how grotesque it is, even when it hasn't started to be destructive. With the clear parallels it has to nuclear weapons, it becomes obvious from nearly every mention and appearance of the Giant Warrior that if it is so grotesque and dangerous, then nuclear weapons must be just as horrifying. This specific scene very well pushes the idea that not only is the use of nuclear weapons immoral but so too is the development of them.

Aside from nuclear weapons, there are other very real weapons displayed in the film that we continue to use to this day. Such weapons include machine guns, shotguns, hand grenades, flash grenades and even larger things like gunships or tanks. While nearly all of these are represented in a very realistic way, the gunships are undoubtedly designed with significant creative liberty as the bodies of these aircrafts do not resemble any real aircraft. However, this does not mean these do not give a good representation of the flaws of such technologies. For examples, see Figures 6 and 7.

All of the previously mentioned technologies of war are portrayed within the film in a distinctly negative way. However, this does not mean that the film means to say there is absolutely no acceptable use of such things; there are also times when these are shown to be neutral or even positive. In truth there is a strong possibility that this

Figure 6. Nausicaä (middle) standing before the weapons that were confiscated by her people, while surrounded by the army which confiscated those weapons. Screen capture from the film.

film means to say that these technologies themselves are not evil, but the way that we as humans interact with them can make them that way. Nausicaä herself uses her gun towards the beginning of the film to remove part of an ohmu shell and she uses flash grenades to stun an ohmu, saving Lord Yupa. In the former instance, the use of the gun is shown in a completely neutral context, with it not even being used on any living thing and with the entire scene remaining quite peaceful; even the choices of

Figure 7. Fleet of ships carrying stolen goods and hostages. Screen capture from the film.

lighting and colors being brighter than other parts of the Toxic Jungle adding to the serenity of the scene. This scene shows that such things can be used without causing any harm whatsoever. In the other instance the grenades are clearly used to stun the ohmu in order to protect and reduce harm for both parties.

In the instances in which these technologies are used in a harmful way, the negativity of it is conveyed both in the expression of the characters witnessing it or by the colors shown in the scene. With the scene of the Giant Warrior being used towards the end of the film, the characters on both sides are clearly in shock and awe of just how destructive this technology can be. Additionally, the use of color in that scene helps in pushing just how the use of these technologies causes far more harm than good. The warrior itself is melting into this dark bloody red sludge; this nasty red is contrasted with its sharp green eyes that appear completely devoid of any sort of soul. Its visage is utterly grotesque and it remains that way till it falls apart.

Other technologies that are more often used in warfare today are also critiqued. Towards the end of the film conflicts arise in the Valley with the people finally fighting back against the Tolmakian forces that have been occupying their land. Prior to this, the valley is shown to be a very peaceful and beautiful place with plenty of lush greenery and farmlands; the downfall of this serene environment begins when spores are found in the forest surrounding the valley. See Figures 8 and 9 for the before and after, respectively.

Initially, the people mean only to use their tools to burn the spores, using fire in moderation in order to solve their problem. However, things quickly get out of hand and they realize that they have no choice but to burn the entire forest down if they don't want the Toxic Jungle to spread into the valley. This is the first time in the film that the valley is shown with colors like black, brown and others that are associated with decay, being more prevalent than greens and other more natural or lively colors. Throughout the entire film the use of fire is heavily frowned upon with Ohbaba warning the Tolmekians of why they should not even attempt to burn down the toxic jungle and, towards the end of the film, several characters going on about why they prefer the ways of the water and the wind over the way of fire since "Too much fire gives birth to nothing. Fire can reduce a forest to ashes in a day, while it takes the water and the wind 100 years to grow one". With this film Miyazaki is urging us to stop relying on fire to solve our problems, both in a literal and figurative sense. This is shown not just through the speech of the characters but also in the way that the scenery changes and the way the characters react to the use of excess fire.

Human & environmental impact

In the film the human and environmental impact of human activities such as war are explored in many scenes. One example

Figure 8. How the Valley of the Wind looks like in a time of peace. Screen capture from the film.

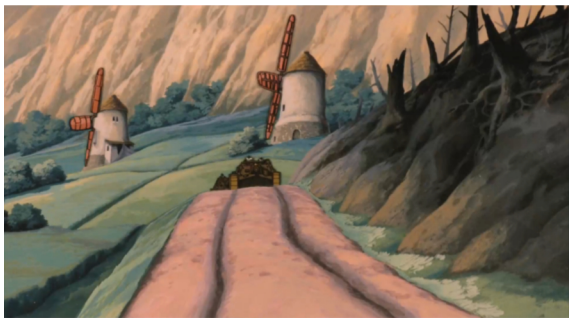

Figure 9. How the Valley of the Wind looks like in a time of war. Screen capture from the film.

of this can be seen in one scene towards the end of the film where Nausicaä and another character, Asbel, fly into the city of Pejite together on Nausicaä's glider (Figs. 10, 11). It had previously been occupied by the Tolmekian forces but as they fly over it, the city is desolate and run down. The film reveals that the people of Pejite baited some of the ohmu into the city and let them wreak havoc in order to drive out the Tolmekians occupying the city. The film tries to show the audience how immoral this decision was not just from the sorrowful and ashamed expressions on the faces of the Pejite refugees and Asbel, the prince of Pejite. It also shows the impact these actions have had on the fauna, as the scenery is full of deceased animals of the Toxic Jungle. Additionally, while it is apparent that the city was once livable, now the characters need to use their masks to even be able to breathe within its premises. This shows that the damage done here was severe as some buildings were broken down, lives were lost and the land has been made uninhabitable for the foreseeable future.

The Pejite use the same strategy again later in the film. In this second instance, they lure the ohmu into the Valley of the Wind in order to keep the Giant Warrior out of the hands of the Tolmekians. There were several scenes which depict this event since it is the major conflict of the film; however, since the previous scene examined focused more on the environmental impact of this act, here the focus is on the human impact. In the scene Mito, who serves sort of as the assistant to Princess Nausicaä, returns to the Valley of the Wind and informs both the people of the valley and the occupying forces of the Tolmekians of the ohmu horde heading towards them. The audience is shown in this scene how much panic and distress the news brings both to the innocent citizens of the occupied territory and to the occupying forces, who were the only real target of this attack. The expressive use of facial expression and body language in this scene helps drive home just how impactful this is, even to the people who were never meant to be a target of this attack. Another scene that comes soon after reinforces this idea, when the insects begin their attack on the valley. This scene is utter chaos, the people attempt to seek shelter and the

Figure 10. The city of Pejite after the Pejite government lured giant violent animals into the city. Screen capture from the film.

Figure 11. The city of Pejite after the Pejite government lured giant violent animals into the city and the reactions of the characters Nausicaä (left) and Asbel (right) when seeing the state of the city. Screen capture from the film.

Tolmekian soldiers who were previously standing without shelter, emboldened by their control of the Giant Warrior, now scramble seeking shelter and clearly fearing for their lives. The expressiveness of this scene comes not only from the facial expressions and body language but also from the shaky and strange positioning of the camera which gives the scene a more panicked feel. In addition, the colors were muddled and the lighting was quite dim, with sudden flashes of bright blaring light that fed into the chaotic nature of the scene. This all works to show just how impactful efforts of war can be to humans, their environment and the other creatures who share it.

LIMITATIONS

Certain aspects of the method I chose when designing this project limited the results of my research. For instance, because I focused only on the visuals, my data does not take into account the role that the script, voice acting (especially the original) or soundtrack played in delivering certain messages to the audience. Additionally, while one can analyze, interpret, and hypothesize the main message(s) in the film and in each scene, it is impossible to extrapolate for all audiences. During the research process for this study, many additional questions have come up, including the following. Firstly, what effects do the audio elements of *Nausicaä* have on the audience? Secondly, can *Nausicaä* even be compared to Western religions given the fact that it was made in Japan? Lastly, how is the film interpreted by younger viewers versus older viewers?

CONCLUSION

Through its stunning visual storytelling, *Nausicaä of the Valley of the Wind* invites its audience to reconsider the toll war takes not just on people, but also the environment. With color, body language, facial expressions, and the overall environment of scenes, Miyazaki warns against the dangers of harmful technology and the moral implications of its use. From the violent and gruesome images of the Giant Warrior and destroyed landscape as a result of the use of war technology, to the depleted and unsafe landscapes and fearful gazes of terrified civilians robbed of their homes and any sense of normalcy, the film seeks to depict the enormous destructiveness that results from war. Additionally, Miyazaki's illustrations are much more than fantasy, nodding toward the real world where parallel destruction occurs via nuclear weapons, environmental crises and modern warfare. The overarching message of the film's visuals serves not only to paint a narrative, but to urge us to meet conflict with empathy, to protect our natural environment, and understand that it takes more courage and wisdom to find peace than to wage war. Although this data is subjective, seeing as it was based on my interpretation of the film's visuals, it still suggests that visual storytelling has the potential to convey the ecologically damaging effects of war. Additionally, this discussion makes a contribution to the academic conversations on film, war and environmental sustainability all at the same time. Offering a visual, scene-based approach to analyzing storytelling that depicts war and environmental crisis in anime. Despite all this, further research is needed on large audience reception of these visual messages, cultural responses to these messages, or the influence auditory elements of film can have in delivering these messages.

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About the author

Audrey Aguirre is a student of Upland High School. She has been fascinated with Studio Ghibli's Films since the first time she saw one and couldn't get enough of the studio's beautiful animation and wonderful storytelling. For the longest time her two favorite films had been *Nausicaä* and *Princess Mononoke*. She can't be sure what the future has in store for her but she hopes she can see many more meaningful films such as the ones she've loved from Studio Ghibli.