

Visual Narrative and Semiotic Analysis: Unpacking the Symbolic Imagery in film *Joker* and *Joker: Folie à Deux*

Jinglei Shi¹

¹ Nanjing University, China

Correspondence: Jinglei Shi, Nanjing University, Nanjing, Jiangsu, China.

Received: October 4, 2025; Accepted: October 17, 2025; Published: October 18, 2025

Abstract

This study applies Charles Sanders Peirce's three-element semiotic model (icon, index and symbol) as an analytical device to explore how visual elements in Todd Phillips's *Joker* (2019) and its follow-up film *Joker: Folie à Deux* (2024) convey meanings. Instead of focusing on plot or themes, the approach deciphers how camera compositions, colour, costume details and choreographed actions function as active signs. In the film, the bleak, worn-out cityscape acts as an icon that mirrors real-world social gaps, points to institutional neglect and conveys a sense of class rebellion. Arthur Fleck's clown makeup and unpredictable dances reference traditional clown imagery, reveal his inner turmoil and trigger collective catharsis. In *Joker: Folie à Deux*, vibrant neon lights and shared dance routines maintain these semiotic processes by means of evoking carnival atmosphere, signalling the unfold of madness and crafting a revolutionary narrative. Through a close study of the films' visual materials across the icon, index and symbol registers, this research shows how the construction of imagery not only shapes the character of Arthur Fleck but also serves as a critical statement at the marginalization of individuals, the breakdown of social order, and the consequences of systemic neglect, and uncovers layers of significance that have previously been overlooked.

Keywords: *Joker*, *Joker: Folie à Deux*, semiotic, Peirce

1. Introduction

Like a prism, Todd Phillips' film *Joker* refracts the fractures of contemporary society. Stripped of the dazzling special effects and grand heroics typical of superhero films, it rather turns its lens on Arthur Fleck, a failed clown and forgotten man at the margins of Gotham. Against the backdrop of the metropolis's grimy, claustrophobic streets, Arthur's maniacal laughter blends with the urban chaos, in the end tearing open a raw and bloody wound of class struggle, violence, and psychological trauma.

Through its visual symbols, the film portrays social injustice, the marginalization of individuals, and the spread of violence. Diverging sharply from the bombastic spectacle of traditional superhero cinema, the movie adopts a gritty, character-driven technique to explore themes of societal alienation, mental health neglect, and systemic inequality. Set against the bleak backdrop of 1980s Gotham City which is a dystopian proxy for urban decay and class stratification, *Joker* reviews the cyclical nature of violence and the dehumanizing effects of overdue capitalism. As the film raked in over a billion dollars worldwide, it also ignited a cultural firestorm over whether it was a "dangerous anthem for the mentally unstable" or a "searing indictment of capitalism's deepest flaws".

Semiotics, the study of signs and their communicative functions, has long been instrumental in decoding cinematic language. From a semiotic perspective, signs can be divided into linguistic signs and non-verbal signs. Non-verbal signs mainly refer to various conventional or non-conventional signs and marks that use visual or auditory mediums to convey information, with the exception of verbal pronunciation and written language (i.e., linguistic signs). These non-verbal signs can clearly communicate the hidden facts and actual intentions of their character-bearing subjects (Wu 2). The development of film semiotics can be traced back to early structuralist approaches, with scholars such as Christian Metz and Roland Barthes laying the basis for understanding cinema as a language of signs. Over time, Charles Sanders Peirce's semiotic framework has been increasingly applied to film analysis, which offers a triadic model that categorizes signs based on their relationship with their referents. His contributions to semiotics have significantly shaped modern film analysis, particularly in understanding how visual and narrative elements function as signs within a cinematic text. This study is informed by Charles Sanders Peirce's semiotic theory, which posits a triadic relationship among the icon, index, and symbol.

Peirce's semiotics originates from his theory of three universal categories, which divides "phaneron", the sum of all phenomena, into firstness, secondness, and thirdness. Based on this theoretical foundation and fundamental principle, he proposed a new list of categories comprising three essential elements, along with his renowned triadic theory of signs. Peirce identified three types of relationships between a sign and its referent: a relationship based on similarity, a relationship based on proximity, and a relationship based on conventionality. According to these three types of relations, Peirce classified signs into three types: iconic signs, indexical signs, and symbolic signs, and he emphasized that these categories can transform into one another (Peirce 558). An icon bears a visual resemblance to its object, an index signifies by causal or existential connection, and a symbol functions via convention.

Peirce's framework is particularly suited to cinematic analysis as film is inherently a visual medium that employs images not only to represent reality but also to evoke emotional and ideological responses. Applying Peirce's triadic model enables a systematic unpacking of how each shot, costume, color palette, and mise-en-scène operates on multiple semiotic levels, thereby revealing layers of meaning that remain latent in narrative or thematic critiques. In *Joker*, semiotic analysis enables a deeper exploration of how visual symbols, such as Arthur's clown makeup, his dance movements, and his eventual transformation into a symbol of rebellion, contribute to the film's thematic construction.

Domestic and international scholarship on *Joker* has converged on the film's psychological portraiture and sociopolitical critique, yet few studies offer a systematic semiotic analysis grounded in Peirce's triadic model. Production designer Mark Friedberg emphasizes how Gotham's decaying streets and oppressive interiors shape Arthur Fleck's world, observing that "Gotham oppresses Arthur as much as anything in the film" (Friedberg 102). However, most academic accounts stop at noting these influences rather than unpacking how each image functions as a sign.

Much literature focuses on Arthur's mental health narrative. Scholars debate whether *Joker* offers a responsible depiction of psychiatric illness: Skryabin praises its "neuropsychological study" of social neglect (Skryabin 331), while Nierenberg warns it risks reinforcing harmful stereotypes by conflating mental illness with violence (Nierenberg 187). The film's depiction of public health cuts is cited as a critique of neoliberal austerity (Driscoll and Husain 192), yet few analyses examine how visual motifs, such as Arthur's tear-streaked makeup, sterile clinic corridors, and the contrast between his clown mask and hospital gown, index his shifting identity and societal marginalization.

Political readings interpret the film as an allegory of class revolt. Uysal's content analysis assigns the Waynes to the bourgeoisie and Arthur to the dispossessed, arguing Thomas Wayne's dictum "you get what you deserve" satirizes the neoliberal American Dream (Uysal 398). Despite insightful thematic readings, these studies remain text-based and do not trace how visual elements, such as graffiti slogans or headlines on news broadcasts, operate as indices of social unrest.

Moreover, academic work on *Joker: Folie à Deux* (2024) is not yet available. The sequel's vivid, musical-driven style and its dialogic structure between Arthur and Harleen Quinzel promise rich material for semiotic analysis, but existing commentary resides almost entirely in non-peer-reviewed forums. This absence of scholarly engagement underscores an opportunity for an academic study that applies Peirce's icon-index-symbol framework to both films' visual narratives.

While Barthesian approaches have been applied to the *Joker* trailer by recognizing visual cues as denotative icons and connotative signs (Lubis and Oisina 125), but no study employs Charles Sanders Peirce's distinction among icons (graphic resemblance), indices (causal connection), and symbols (conventional meaning) to analyze the films' imagery. This lacuna is striking given the abundance of rich visuals: Arthur's red suit and painted grin could be read iconically as clown archetypes, indexically as markers of his transformation, and symbolically as emblems of anarchy. Similarly, the sequel's kaleidoscopic palette and musical interludes demand a semiotic unpacking to reveal how they encode shifting power dynamics between Arthur Fleck and Joker.

A dedicated visual-semiotic analysis is vital because it shifts the focus from narrative interpretation to the film's materiality whose images serve as active signifiers. In *Joker*, the recurrent motif of mirrors not only reflects Arthur's fractured identity but also symbolizes society's refusal to acknowledge its own complicity in marginalization. Similarly, *Folie à Deux*'s vibrant color palette and musical sequences encode the dialectic between ecstasy and madness, demanding a semiotic unpacking that narrative or thematic studies alone cannot provide. By applying Peirce's semiotic framework, this study will bridge existing thematic critiques with a systematic visual analysis. It will demonstrate how specific images function on multiple semiotic levels to express

psychological turmoil, societal oppression, as well as the promise and peril of revolutionary identity, thereby filling a critical gap in *Joker* scholarship.

2. Semiotic Structure of Gotham City

In *Joker* and *Joker: Folie à Deux*, Gotham City and its visual construction are not mere backdrops but active “signs” in Peirce’s sense, operating iconically, indexically, and symbolically. By examining production design, cinematography, and mise-en-scène through these three registers, this thesis would reveal how each film stages Arthur Fleck’s internal and external worlds and how the city itself transforms from oppressive terrain to a site of collective spectacle.

2.1 Production Design & Cinematography

The 2019 film *Joker*, directed by Todd Phillips and shot by Lawrence Sher, serves as an exemplary case of how cinema functions as an iconic symbol of reality. According to Charles Sanders Peirce’s semiotic theory, an icon is a sign that represents its object by resembling it. In this context, film as an art form inherently possesses an iconic nature because its images directly mirror reality, albeit through a mediated and stylized lens. *Joker* amplifies this iconic function by employing hyper-realistic cinematography, raw performances, and socio-political themes that closely reflect real-world struggles. The film’s formal techniques, including cinematography, mise-en-scène, and sound design, function as indices that point to tangible social and psychological conditions without relying on symbolic abstraction.

The film’s use of naturalistic lighting, and muted color grading all contribute to an aesthetic that closely resembles documentary filmmaking. The technique enhances its iconicity, making the audience perceive the fictional world of Gotham as an extension of their own social reality. Cinematographer Lawrence Sher’s use of handheld cameras and desaturated filters replicates documentary footage of urban blight, establishing a causal link between the film’s visuals and historical realities. He underscores the film’s commitment to a gritty, desaturated look and depicts a palette that situates Arthur’s struggle within a palpably hostile environment. By evoking the late 1970s and early 1980s through Scorsese-inspired framing and lighting contrasts, *Joker* embeds class conflict into every frame. The depiction of Gotham’s trash-strewn streets and overcrowded subway systems directly mirrors the austerity-driven decline of 1970s New York City. The cramped, yellow-lit interiors of Arthur’s apartment function as an index of his psychological confinement. The camera’s tight framing and shallow depth of field mimic claustrophobic home videos of individuals living in single-room occupancy housing. The flickering fluorescent lights, a technical choice measured to replicate faulty wiring in low-income housing, create a strobe effect that visually triggers the unease associated with institutional neglect.

Gotham City in *Joker* is not merely a setting but an integral component of the film’s semiotic framework. It functions as an indexical sign, a sign that points to its object through causal or existential connections, by reflecting the societal decay, economic disparity, and political unrest that define Arthur Fleck’s world. Unlike traditional representations of Gotham in earlier Batman films, which often leaned into gothic or neo-noir stylization, *Joker*’s Gotham is grounded in stark realism, resembling a late-1970s or early-1980s New York City. This grounded portrayal enhances the film’s semiotic depth, as Gotham becomes an indexical signifier of real-world urban struggles.

One of the most striking aspects of Gotham’s environment is its visual degradation. The city is characterized by dilapidated buildings, overflowing trash due to the sanitation strike, and hostile public spaces. This urban decay serves as a metaphor for societal neglect and disintegration, visually reinforcing the film’s themes of alienation and systemic failure. The visual design of Gotham City (such as trash, rats, and chaotic streets) resembles the slums in reality, conveying a sense of oppression in the lower classes. Gotham is depicted as a cold, inhuman steel cage. Its muted grays and blues replicate the somber tones of 19th-century circus posters, where dark backdrops highlighted performers’ vivid costumes. Arthur’s green hair and red smile, though distorted, retain the primary color scheme of traditional clown iconography (red, yellow, blue), as seen in works like Picasso’s *The Frugal Repast* (Zhang 10). The film’s lighting, such as harsh fluorescents in subway scenes, mirrors the stark spotlights of circus arenas. It reinforces the iconicity of performance spaces. The accumulation of garbage and graffiti throughout the cityscape indexes a breakdown of public services, which in turn correlates with the breakdown of Arthur’s mental stability. The more Gotham descends into chaos, the more Arthur loses his grip on reality, demonstrating the symbiotic relationship between character and environment.

The film also uses a technique of deprivation and empty spaces, weakening the city’s depth and spatial sense, while denying marginalized individuals breathing room and opportunities for upward mobility. The stark contrast between the affluent elite (represented by Thomas Wayne’s luxurious lifestyle) and the impoverished lower class, struggling to survive in a deteriorating city, highlights the vast socioeconomic divide. The film frequently employs

claustrophobic framing, narrow alleyways, and towering buildings to evoke a sense of confinement, mirroring Arthur's growing sense of isolation. His apartment, dimly lit and suffocatingly small, reflects his psychological imprisonment, and displays a stark contrast to the open, chaotic energy of the riots in the film's climax. The use of a narrow 1.85:1 aspect ratio visually restricts horizontal space, mirroring the constrained perspectives of marginalized communities. This format choice directly references 1970s political thrillers like *Taxi Driver* (1976), whose visual claustrophobia indexed urban alienation. The cityscape, its crumbling infrastructure, and the palpable social tension mirror real-life urban decay and economic disparity, reinforcing the film's status as an iconic representation of systemic failures.

On the symbolic level, production design elements carry established cultural codes. Arthur's apartment is furnished with peeling wallpaper, functional but worn furniture, and harsh fluorescent lights, symbolizing neglect and the cold bureaucracy of social services. In addition, The film was shot during the magic hour, just before or after sunset with the utilization of the blue natural light of high color temperature to cast a melancholic and cold atmosphere over Gotham. Gotham is portrayed as a towering, impersonal steel cage. By depriving the background, the depth and spatial sense of the city are weakened, depriving the marginalized of their breathing space and upward mobility. Entering the residential building, the tone shifts from blue to orange, with warm colors symbolizing safety, comfort, and softness, giving a sense of home.

2.2 Gotham City as a Sign with Triple Interpretation

The story is set in Gotham City which functions as a triadic sign in Peirce's model. The city iconically resembles a decayed metropolis, indexically points to social realities, and symbolically embodies moral and political meanings.

Peirce's iconic relationship foregrounds visual resemblance. In *Joker*, Lawrence Sher's desaturated palette and tight framing render Gotham as a decayed mirror of 1970s-80s New York, with trash-strewn streets and graffiti-scarred walls directly recalling urban blight. In the sequel, this iconography appears again: neon-lit alleys and brightly painted carnival sets visually echo the first film's grit, yet through a stylized prism that resembles a lurid stage-show.

Through its indexical dimension, the city's physical details point to underlying social forces. Gray rats scuttling through Gotham's alleys serve as companions to Arthur, their lifeless eyes and scavenging behavior index his creeping paranoia and social decay. The omnipresent trash such as crumpled flyers and discarded soda cans symbolizes the discarded emotions and failed social contracts that have accumulated around him. The overflowing trash bins and shuttered clinics index systemic neglect and austerity policies that leave Arthur Fleck abandoned. They visualize an external world as fractured as his inner life. In *Folie à Deux*, the same streets, now repainted in lurid pinks and greens, index a collective delirium. They mark not only a breakdown of public order but the spread of Joker's own psychosis into the masses.

As a symbol, Gotham carries conventional meanings that evolve between the two films. Gotham symbolizes moral decay and class division. Its high towers loom over the destitute, signifying the entrenched gap between Wayne wealth and Fleck poverty. The neon facades and musical numbers transform the city into a stage for revolutionary myth-making. Gotham has become a symbol of collective catharsis and anarchy, where clown masks in windows announce an uprising against social norms.

Together, these three semiotic registers show how Gotham shifts from an icon of urban despair, through indices of neglect and contagion, into a symbol of both revolt and shared psychosis, which lays the groundwork for Arthur's transformation into the Joker and its diffusion into a mass myth.

3. Visual Construction of the Joker Persona

3.1 Visual Coding of Costume and Makeup

Charles Sanders Peirce defines iconic signs as representations that physically resemble their referents through formal or structural similarity. The clown persona visually echoing the familiar circus archetype with its own peculiar twist. For instance, Arthur's unevenly smeared makeup and exaggerated red grin resemble a classic "hobo clown", yet the intentional asymmetry and rough edges underscore his outsider status. Moving beyond mere resemblance, the makeup also functions as an index of Arthur's inner turmoil. The streaked blue triangles under his eyes point directly to tears he cannot shed, signaling emotional fracture and societal rejection. Finally, the painted smile takes on symbolic weight. In the first film, it becomes shorthand for rebellion appearing on graffiti and protest signs to signify discontent and is transformed into a symbol of their shared psychosis and collective uprising. The film merges these types to create a hybrid symbol. In *Joker* (2019), Arthur Fleck's makeup and

exaggerated smile function as direct visual icons, replicating historical clown imagery while recontextualizing their formal traits within a modern narrative.

The clown image in DC comics is difficult to trace to a single historical prototype. Rather than originating solely from circus clowns and court jesters, it is a symbolic code composed of a mixture of various elements (Sun 31). The clown image incorporates the witty, eloquent, and glib characteristics of European jesters, the white-faced, red-lipped appearance of circus clowns, the tragicomic “permanent smile” inspired by Victor Hugo’s *The Man Who Laughs*, the imagery of the Joker and King from playing cards, and the complex economic and political environment of the time in the United States. Phillips’ film selectively borrows and recontextualizes these elements to craft a narrative steeped in semiotic complexity. For instance, Arthur’s garish makeup--a cracked, blood-red grin superimposed on chalk-white skin--serves not merely as a nod to comic book aesthetics but as a visual metaphor for societal masks and fractured identity. Similarly, his flamboyant purple suit, reminiscent of earlier DC adaptations (e.g., Heath Ledger’s Joker in *The Dark Knight*), is reinterpreted as a symbol of performative rebellion against bourgeois norms. By juxtaposing these inherited motifs with original innovations, such as Arthur’s compulsive laughter (a physiological condition reframed as psychological torment), the film transforms the Joker from a comic book antagonist into a polysemic emblem of societal collapse.

The clown archetype spans diverse cultures. In ancient Egypt and Rome, court jesters mediated social tensions through satire, while Roman pantomimus performers used physical comedy to critique authority. During the Warring States period, “pai you” employed humor to indirectly challenge power structures. In European Pantomimem, the 18th-century Pierrot’s white mask epitomized the plight of societal outcasts (Zhang 5). Arthur inherits the tradition of subversion. His transformation into the Joker mirrors the historical shift of clowns from entertainers to social critics, which embodies the rage of the disenfranchised in Gotham’s decaying urban landscape.

Table 1.

Type	Visual Traits	Symbolic Meaning	Film Adaptation
Whiteface	White base, refined features	Tragic conformity to authority	to Arthur’s initial mask of societal compliance
Auguste	Colorful chaos, slapstick	Disruption of order	Arthur’s red suit during anarchic acts
Tramp/Hobo	Tattered clothing, disheveled	Marginalized rebellion	Arthur’s final identity as a societal outcast

Clown images are often categorized into types such as Whiteface, Auguste, and Tramp(or Hobo). Arthur’s stark white face paint directly mirrors the Whiteface Clown, a figure originating in 18th-century European pantomime. As noted in studies of clown typology, Whiteface clowns like Pierrot wore chalk-white makeup to signify theatrical neutrality, enabling exaggerated expressions to be visible to distant audiences (Zhang 8). The film replicates this tradition: Arthur’s featureless white base erases individual identity, echoing the Whiteface’s role as a blank slate for performative extremes. The thick, uniform application of paint, a technique documented in historical clown manuals (Zhang 9), emphasizes artifice over humanity, aligning with Peirce’s concept of icons as formal imitations.

The red smile, painted in a grotesque upward arc, replicates the Auguste Clown’s signature grin. Auguste clowns used oversized mouths and bright colors to amplify comedic expressions (Zhang 9). In *Joker*, however, the smile’s edges extend unnaturally beyond Arthur’s lips, distorting Auguste’s intent into a grotesque parody. This visual exaggeration retains the icon’s formal structure (a curved line representing a smile) while altering its contextual purpose--a shift explored in later chapters.

Moreover, Arthur’s ill-fitting suits and muted color palette directly reference the Tramp (or Hobo Clown), a Depression-era archetype characterized by patched clothing and disheveled appearance (Zhang 8). The sagging sleeves and oversized trousers mirror historical photographs of Tramp clowns like Emmett Kelly’s “Weary Willie”. By adopting these visual traits, the film positions Arthur within a lineage of clowns whose physical disarray signifies social marginalization as a direct visual citation.

Joker reconfigures traditional clown iconography into a semiotic battleground. Arthur’s makeup and smile are not mere aesthetic choices but multilayered signs that critique capitalism’s dehumanizing forces. As Arthur slips further into the Joker persona, the color of his costume shifts to mirror his psychic fracture. His signature red jacket taht is bold and unrestrained embodies the id, the anarchic force within him that rejects society’s rules and revels in unbridled impulse. Beneath that jacket, a bright yellow shirt peeks out. It is almost entirely submerged by the

red overcoat. The yellow represents the ego, Arthur's striving, rational self, which struggles to maintain balance but is consistently overridden by darker drives. Finally, the hints of teal-blue in his vest and inner layers evoke the superego, the internalized voice of conscience and social order. These cool tones cling to him only in fragmentary flashes, which suggest how codes of morality and convention are present but largely suppressed. We can spot the id asserting itself, the ego battered, and the superego reduced to a faint, flickering light.

By referencing and reinventing established symbols, *Joker* situates its protagonist within a continuum of social outcasts and dissenters. This intertextual dialogue enriches the narrative, as the costume and makeup both honor and transform the legacy of clown figures, ultimately functioning as a visual indictment of a society that both exploits and abandons its most vulnerable members. The Joker is both a product of and a reaction to the socio-political environment, highlighting how symbols can carry the weight of cultural and political critique.

Arthur Fleck's visual transformation is marked by a radical reinterpretation of traditional clown iconography. His stark white makeup and exaggerated red smile evoke historical figures from European theater and traditional circus clowns, yet these familiar images are recontextualized to signal alienation and subversion.

3.2 Expressive Function of Bodily Performance

Indexical signs convey meaning through a causal or proximate relationship with their objects. Like demonstrative pronouns or relative pronouns, they direct attention to specific objects without describing them (Peirce 369). In the film body expressions are mainly used as indexical signs to indicate the psychological and social state of the protagonist. The direct causal relationship between the changes in his body and acts of violence suggests that Arthur's psychological breakdown is directly tied to the oppression of his social environment, guiding the audience's interpretation of the character's psyche. His physical pain is not only a narrative device but a potent index of his internal struggle. The tense posture, grimaces, and subtle bodily reactions serve as non-verbal cues that point directly to a deeper, often unspoken, emotional agony. The close-up shots that capture these physical expressions reinforce the causal link between his bodily suffering and the oppressive societal forces that have contributed to his psychological breakdown. Arthur's pathological laughter, often interpreted in isolation, is better understood as a facet of his overall bodily language.

The involuntary bursts of laughter, occurring at moments of extreme distress, function as indexical signs of internal conflict. They reflect his inner pain and dissatisfaction with society and reveal a paradoxical state where humor, usually a socially adaptive behavior, transforms into an expression of existential despair. This laughter which is disjointed, out of context, and deeply unsettling mirrors his fractured psyche and the inability to reconcile his internal suffering with external realities. The uncontrollable and sometimes inappropriate laughter of the smiling face shows his sadness, his pain, grievance, fear, and despair. The high contrast of emotional expression creates a repressed atmosphere and a strong sense of tension in the film.

The origin of Arthur's manic laughter can be traced back to the severe abuse and neglect he experienced within his original family during childhood, which ingrained a deep, inherent pain in his mind and unconsciously constructed a worldview steeped in suffering and sorrow. His mother's neglect, coupled with a reverse form of education, left young Arthur utterly confused; while he was enduring immense physical and emotional torment, his mother would tell him to keep smiling and to bring happiness to everyone. To the child Arthur, the outside world appeared superficially beautiful and harmonious, yet underneath it was filled with deceit and brutality. This discrepancy led to a duality in Arthur's personality: a conflict between his inner world and the external reality, basically between his "true self" and the world as it is. Freud, in his book *Introductory Lectures on Psychoanalysis*, proposed the theory of psychological defense mechanisms. He pointed out that these mechanisms are an individual's way of coping with pain and anxiety (Freud 548); Arthur's manic laughter is a form of counterreaction aimed at rationalizing his tragic experiences.

The recurring motif of "laughter" in *Joker* forms a complex network of indexical signs. Arthur Fleck's pathological laughter initially manifests as an involuntary physiological response, likely stemming from neurological damage due to childhood traumatic brain injury (TBI). This uncontrollable laughter, occurring at socially inappropriate times, serves as an index of his psychological distress and social alienation. For instance, when Arthur is dismissed from his job at the children's hospital, his forced smile and involuntary laughter underscore the intersection of personal trauma and systemic neglect. Similarly, his feigned laughter at his mother's bedside points to the oppressive familial dynamics and the expectation to mask true emotions. Most poignantly, the final scene where Arthur smears blood into a smile on his face symbolizes the culmination of his transformation. This act, born from physical trauma, becomes an index of his complete descent into the Joker persona, encapsulating his individual suffering and the broader societal failures that contributed to his metamorphosis.

Freud proposed that the personality is composed of the id, ego, and superego. The id represents the desires in the unconscious and lies at the deepest level of the personality, operating according to the pleasure principle. The ego is the aspect of consciousness responsible for dealing with issues in the real world and constitutes the middle layer of the personality structure. The superego, representing the idealized self, stands at the highest level and acts as the moral self, striving for perfection. Most of the unconscious content belongs to the ego, where it remains hidden. Arthur was deprived of the right to grieve from an early age, so his ego has been continuously repressed. After enduring various painful encounters within a distorted and complex society, Arthur finds it extremely difficult to genuinely laugh. However, many scenes in the film show him repeatedly using his fingers to pull up the corners of his mouth into a “smiling” expression. At this point, the film suggests that Arthur’s smile is a form of compulsive self-expression and a manifestation of a repressed self (Qiao 26).

The film presents Arthur Frank’s loud, manic laughter in many scenes. Arthur is aware that this is a mental disorder, and he needs to see a community psychologist regularly to treat his bouts of uncontrolled laughter. In the first scene, Arthur is in the midst of a session with a therapist, continuously laughing. At first, the audience assumes his laughter to be one of genuine joy, and the shot lingers on him for quite some time—a process that feels almost unbearable, as if it might expel his very organs. Gradually, the audience realizes that this is not a “happy” laugh, but rather one of helplessness. Minutes later, Arthur abruptly stops laughing, and his expression becomes serious and pained. The camera then shifts to the doctor’s inquiry, revealing that Arthur suffers from an uncontrollable condition that often leads him to fitful bouts of laughter.

Arthur’s physical manifestations of pain and disjointed laughter not only signal personal distress but also mirror the societal neglect and alienation pervasive in his community. The incongruity between his outward appearance and the expected social comportment underscores the failure of a system that marginalizes individuals, rendering his bodily expressions as powerful indicators of both personal and collective trauma. From a comedian trying to integrate into society to ultimately becoming a rebel against it, Arthur’s transformation is a complex signifier.

In *Joker*, dance sequences are both choreographed movements and powerful semiotic signs that articulate the protagonist’s internal metamorphosis. It functions as a bodily language that conveys shifts in emotional states and the gradual emergence of the Joker persona, and reveals inner fluctuations and embodying the internalization process of becoming the true Joker. In *Joker* (2019), there are 4 pieces of shootings and 7 times of dances. In *Joker* (2024), there are a total of fourteen song-and-dance segments (fantasy, hypnosis, summoning)(Wu 43). Through carefully composed choreography, the film transforms physical movement into an index of psychological liberation and rebellion.

The initial awkward dance steps reflect Arthur Fleck’s struggle with social conformity and internal repression. His hesitant, stilted movements underscore the conflict between his suppressed identity and the expectations imposed by a hostile society. As the narrative unfolds, the dance evolves into a more fluid and exuberant expression which mirrors his descent into chaos and the full emergence of his anarchic alter ego. In this context, dance becomes a ritualized performance where movement itself indexes the dissolution of conventional identity.

Furthermore, the spatial dynamics of these dance sequences, such as the interplay between confined spaces and open, unstructured environments, serve to amplify the internal conflict. The gradual shift from rigid, controlled movements to expansive, uninhibited gestures is emblematic of Arthur’s journey from isolation to a more liberated, albeit destructive, form of self-expression. Every time he dances, he enters the world of himself, which is both a process of self-reflection and the result of catharsis. Thus, the dance in *Joker* is a multifaceted semiotic tool that not only charts the transformation of the character but also symbolizes the broader societal breakdown that fuels his metamorphosis.

Bakhtin believed that carnival is predicated on a division between two worlds or ways of life. One is the official, serious, and strictly hierarchical world of order. The other is the carnival-square way of life, in which, during folk carnival festivities, the official order is upended in favor of a utopian world of revelry. The clown’s dance undoubtedly creates a new space. In this moment, Arthur is immersed in the realm of imagination. Imagination is the most fundamental structure of human existence, and its basic characteristic is either “identification” or “alienation”. Arthur’s imagination is marked by alienation, yet within it, he also seeks a sense of identification.

Iconically, his stairwell dance in *Joker* recalls a twisted ballet with each leap and stumble visually resembling both exuberance and imbalance, capturing his rebirth in motion. At the same time, this choreography indexes a shift in power. His slumped, defeated posture gives way to confident, expansive gestures, marking the moment he sheds societal constraints. Symbolically, that very dance has become the film’s ritual: it signifies Arthur’s rite of passage from victim to villain, a performance that cements his new identity. In *Folie à Deux*, shared routines like synchronized spins and mirrored steps perform this triadic function again. They look like stage-musical numbers

(icon), point to the spread of Joker's mania into Harley's psyche (index), and stand for their joint revolution against convention (symbol).

Arthur's use of his left and right hands in different contexts is causally related to his inner personality split, with the right hand representing the "ego" and the left hand representing the "id". The film shows the occupation of the Joker personality through Arthur's actions such as writing and shooting. Arthur's left hand represents the Joker personality, and writing, shooting with the left hand, and tightly pressing the right hand are signs that the Joker dominates.

Arthur's repeated act of firing his left-handed shots signifies the rise of his id. The first time he fires is when he has lost his job and unable to suppress the onset of his condition, which consequently incites ridicule and bullying. He shoots and kills three people in quick succession before dashing to hide in a subway station restroom. When he faces his reflection in the mirror, he begins a bizarre yet somewhat graceful dance, spreading his arms to embrace the elusive demon within his own heart. The second time he fires, he methodically and decisively kills a colleague at home who had betrayed him. The final shooting occurs during a live television broadcast to which he was invited by his idol. On the show, Arthur candidly admits to having killed someone, declaring that the world is rotten and that he will execute his idol with a single shot. These successive acts of shooting gradually expose the demonized inner self, unleashing his repressed identity in a wild and unbridled catharsis.

The staircase appears multiple times in the film. The staircase, one of the film's most visually significant locations, symbolizes this transition: initially depicted as a place of struggle (as Arthur ascends it in exhaustion), it later transforms into a stage for his rebirth as Joker when he dances down it, fully embracing his new identity. Every time Arthur returns home, he has to climb a long flight of stairs. As he ascends, his back is hunched, and his steps are heavy and slow. Climbing the stairs symbolizes Arthur's struggle to suppress his inner darkness, his effort to fit into society, seek approval, and move away from the metaphorical "hell". In contrast, when Arthur descends the stairs, whether after being fired from his job or on his way to the talk show *The Murray Franklin Show*, his steps are light, and his expression is relaxed. The descent represents the deepening of Arthur's consciousness and the worsening of his life.

3.3 Symbolic Use of Environmental Color

The environment also plays an important role as Indexical Signs. As the broader environmental conditions of Gotham City have been examined in previous chapters, here we highlight how Arthur's bodily expressions possess symbolic inference by interfacing with his status quo in society. The subway system, a recurring location in the film, becomes a microcosm of this conflict. The brutal murder of the three Wall Street businessmen in the subway car marks a turning point in Arthur's transformation and serves as a symbolic act of class rebellion, where the oppressed retaliate against the privileged. This moment reinforces Gotham's role as an indexical sign, linking urban violence to deeper socio-economic frustrations.

The transformation of Arthur Fleck into the Joker is marked by a deliberate shift in color, reflecting his internal metamorphosis. Contrasting colors like blue and yellow are adopted to create an extreme disparity in mood. At first, the main color is cyan, reflecting the character's mood, rendering a suppressed and sad atmosphere, expressing inner depression, gloom, and despair, reflecting the social environment. After the protagonist is taken over by the Joker's main personality, the film uses more red and yellow, with colors becoming bright and lively, which reflects the liberation of the character's inner self. As Arthur's suppressed emotions give way to anarchic passion, warmer tones (particularly reds and yellows) emerge in his costume, makeup, and even in select lighting choices. Red, often associated with violence and intensity, symbolizes the eruption of repressed anger and the radical rebirth of his identity. Yellow, on the other hand, introduces an element of distortion and theatricality, emphasizing the paradox between his outward appearance as a clown and the inner turmoil that drives him. Yellow taxis represent the self, which blocks Arthur when he decides to make a change, and Arthur eventually succumbs. When Arthur first mustered the courage to go on stage, the scene lighting transitioned from cyan to red. It shows Arthur's struggling, uneasy, and nervous inner world. The spotlight hit his face, and the shooting deliberately used overexposure to present the character's white face, aiming to highlight his poor performance skills and inappropriate laughter with a malicious interrogation-style lighting. The Joker's red jacket and the crimson hues of his makeup symbolize the id--Arthur's primal drives and destructive potential--asserting dominance over reasoned restraint. During the finale's song and dance on the court-room stage, under dim ambient light, bright red spotlights blaze down. The stark color switch indexes the Joker persona taking full control, transforming violence into performance and chaos into liberated expression.

The juxtaposition of red, yellow and blue creates a visual metaphor for the duality within Arthur's psyche, and displays a conflict between conformity and rebellion. This dynamic interplay resonates with psychological theories

of the divided self, reinforcing the idea that these color shifts are not arbitrary but deeply embedded in both cultural history and personal transformation. Additionally, through the use of color, the contrast in temperature and emotion between the fantasy world and the real world is shown. Unlike reality, the fantasy world has a colorful backdrop, with distinct colors contrasting with the previously monotonous yellow and blue tones on the screen. When Arthur dances with Quinn in his fantasy, the stage is highly saturated, and the blue is no longer bleak.

4. The Demise and Mythologization of the Joker

4.1 Climax as Semiotic Apex

On the stand, Arthur again appears as the heavily made-up Joker. The Joker begins to seize control of this “trial of the century”, and both the spotlight and public opinion focus squarely on him and Harley Quinn. Just as it seems the Joker is about to sway the narrative in his favor, the arrival and testimony of the dwarf Gary reawakens Arthur’s dying persona. In his final statement, Arthur refuses to escape punishment by claiming “split personality” and instead accepts full responsibility for his crimes. In doing so, he shatters the faith of his fanatical followers (including his lover, Lee Quinzel)--these so-called devotees mostly had only been using the Joker as a conduit for their own evil or as redemption. The courthouse is bombed, and Arthur manages to escape, but by then he is no longer seen as a divine figure. Recaptured and sent back to the asylum, he is murdered by a crazed Joker zealot. As the killer emits a maniacal, clown-like laugh, Arthur’s life comes to an end.

In the end, Arthur is about to receive a visitor. Before stepping out, a guard close to Arthur walks by singing the 1939 song *We Three* with the lyrics “We three, we’re all alone, living in a memory / My echo, my shadow, and me / We three, we’re not a crowd, we’re not even company” (McCartney 0:10-0:28). Here, “me” represents Arthur, “shadow” represents the Joker, and “echo” represents the Joker’s fanatical followers like that bald man. They cannot accept Arthur’s unremarkable fate and demand he pay for their disappointment. In the final image, Arthur lies in a pool of blood, and the same blade that pierced his abdomen tears the corners of murder’s mouth into a grotesque smile who became the next “Joker”. The striking, tableau-like composition of this scene turns the Joker’s demise into an icon, and makes the apex of the story’s climax.

In the finale there is also an intercut stage fantasy sequence in which Harley Quinn shoots Arthur. In fact, both Harley Quinn and the asylum zealot (the bald-headed killer) serve as the “echo” in the song *We Three*. These fanatical followers of the Joker, imitating the way he once killed Murray, arm themselves and murder the Joker in hopes of becoming the next him as well as the next idol in the spotlight. However, actually the very birth of the Joker persona was meant to stand against violence, not to embody it, which is a tragic result of a cold, indifferent society and an unhappy childhood. The Joker’s slaying by fellow underdogs at society’s bottom is absurd and deeply thought-provoking. In the asylum, those who once worshipped the Joker ultimately become his executioners. This not only exposes the brutal reality at society’s margins but also forces us to reflect on the fact that in our time, mutual harm among the weak has become commonplace. This norm, in turn, makes us feel unsettled and uneasy. At the bottom of society, due to lack of power and scarce resources, the weak often act without restraint. In 1996, Bellinger published an essay in which he gave a precise explanation of the roots of violence: “The basic root of violence is the turn of the human soul away from God in an attempt to control the process of creation and lessen the pain of anxiety. Violence is a means of fortifying a particular immature formation of the ego against the possibility of the ego’s ‘death’ and ‘rebirth’ in a more mature formation” (Palaver 13). To survive and for their own interests, people do not hesitate to harm one another.

The Joker, once a beacon of hope for those same marginalized people, ultimately could not escape this fate. His death drags the personal tragedy brought about by society to the extreme. The Joker’s abandonment of his cause is more than a personal tragedy. It extinguishes the faint hope of everyone who longed for a brighter future. In *The Shawshank Redemption*, hope is the pillar that sustains the protagonist, but in *Joker* (2024), the Joker’s surrender plunges us all into despair. That fragile hope, once flickering with promise thanks to the Joker’s “rebellion”, is snuffed out by his own hand, casting everyone who believed in a better tomorrow into profound darkness. Ultimately, it is the other patients in the asylum who act as the executioners of the Joker--not the law, not a mighty force, but seemingly helpless victims. The sorrow of this ending goes far beyond the simple tragedy of the weak killing the weak. This rebellion and disunity among the marginalized further deepen the film's reflection on the collapse of social order.

The animation at the beginning of the film *Joker* (2024) with the central motif “I” (Arthur) and “my” shadow resembles the real and counterfeit Monkey King. They are identical in appearance, costume and movement much like those two figures. Because “I” refuses to become the Joker, “I” am locked away in a cabinet by the shadow. Meanwhile, the shadow takes to the stage and delights the audience. When “I” return to the once-familiar world, “I” discover that no one needs “me”. People are enthralled only by the mad Joker, in other words the shadow. This

animation vividly portrays the intense tug-of-war between Arthur and his shadow and hints at his vacillation and struggle between being the Joker and being himself. Through the animation and the courtroom scene, the film stages Arthur's ultimate showdown with his Joker persona. The final courtroom drama carries a clear echo of that initial sequence. According to Freud's model of the mind, the id represents the Joker since it acts without regard for society, while the ego embodies rationality and suffers in its struggle to find balance; in contrast the superego takes on society's moral standards and values. In Lacan's framework, the Symbolic order describes the system of social rules and forms the individual's link to the world. In the film, Arthur is repeatedly rejected and marginalized by society, so he cannot find a place within those rules. The Imaginary realm covers fantasy and the fictive self (Lacan 66). The song-and-dance daydreams in the movie show Arthur escaping into his own Imaginary and construct an ideal world that does not exist. The Real encompasses what lies beyond language and symbols. Arthur's inner suffering and the trauma of being cast aside represent that Real, a kind of pain that cannot be eased through language or social rules. From this painful impasse the Joker persona is born. These two personalities do not operate in isolation but are entwined and co-dependent just like the live-action Joker and his shadow in the opening animation. Each of them yearns for the spotlight on stage and at times they seem indistinguishable. Arthur's death transforms the Joker from a mere character into the emblem of a revolutionary myth, and in doing so he comes to represent the oppression and alienation endured by the masses.

4.2 From Persona to Myth

Arthur's death elevated this personal tragedy to a collective myth. After his death, the Joker persona transcends his mortal coil and spreads through Gotham's underbelly. In both films of the series, Arthur Fleck is depicted as being rescued by protesters. In the first movie, he joins the crowd in cheering and dancing. The sequel places even greater emphasis on these supporters, most of whom are dressed as Jokers. Their attire and facial makeup closely resemble his own. The sight of countless citizens donning clown masks signifies the transition from individual symbol to collective convention, marking the metamorphosis of the tragic protagonist into a cultural icon. Beyond individual transformation, the Joker emerges as a potent symbol of collective discontent. His persona encapsulates the disintegration of social order, serving as an embodiment of the systemic neglect and economic disparities that permeate modern society. The Joker's chaotic image becomes a rallying signifier for those who feel alienated by a failing socio-political system. The adoption of radical visual markers by the Joker not only marks his personal metamorphosis but also functions as an act of resistance. His transformation is staged as a public performance. It is a symbolic uprising against the expectations and constraints of a rigid social order. The emergence of new "Jokers" within the asylum illustrates how ideology can spread like a contagion. Furthermore, the young man in the psychiatric hospital who kills Arthur becomes the next Joker, inheriting both the violence and the tragedy. All of this serves as Arthur's legacy, transforming the "Joker" into a legend. By aligning Peirce's iconic signs with Gotham's visual dystopia, the symbol of clown is transformed into a direct display of societal rupture which serves as a mask that both conceals and reveals the fractures of a broken world. Rather than serving as mere comic relief, the elements about Joker become cultural codes that critique societal norms and mask the pain of marginalization.

In *Thus Spoke Zarathustra*, Nietzsche posits that humanity can only free itself from old constraints and create new meanings and selves by destroying false idols and reevaluating all values (Nietzsche 121). The Joker sequel returns to the Joker in his most human form as Arthur, as a person, and as a mental patient. It focuses on his social reality, personal struggles, and the pain caused by his dual identity. This portrayal dismantles the Joker symbol from its position as an unsettling and disruptive idol and breaks it down to reveal how the Joker ultimately consumes Arthur and even himself. In the first Joker film, the character embodies Nietzsche's proclamation that "God is dead" and his Übermensch theory, completing the transformation from underclass victim to symbol of rebellion. Society itself has created a god. In the sequel, director Todd Phillips deliberately subverts the traditional heroic narrative, ending in a muted tragedy where Arthur's death goes unremembered. This intensifies the sense of real-world powerlessness. The finale reveals mutual destruction among the oppressed. Those from the bottom who once worshipped the Joker kill him because they cannot tolerate their idol's perceived betrayal. This satirizes the absurdity of blind devotion and identity politics. At its core, this is an attempt at self-redemption by the oppressed. However, the conflict between society and the individual proves irreconcilable, culminating in the complete collapse of the "Joker myth". The fallen Joker becomes both a martyr and a symbol of contagion. The image of a stranger, newly painted and self-mutilated, standing where Arthur fell becomes a conventional martyr icon which represents not only the persistence of the Joker myth but the cyclical nature of fanaticism. The new Joker's maniacal laughter and self-inflicted smile underscore a sobering truth that when society venerates violence as identity, it replaces empathy with spectacle, and redemption becomes impossible.

5. Conclusion

This research demonstrates that every element of cinematic design in *Joker* and *Joker: Folie à Deux* functions as a multilayered sign, operating simultaneously on iconic, indexical and symbolic levels. Gotham's decaying urban scenery, Arthur Fleck's evolving clown persona, his bodily gestures and choreographed sequences collectively articulate themes of social alienation, systemic injustice and the contagion of violence. The sequel's intensified colour palette and intertwined performances deepen these semiotic processes, showing how individual despair can evolve into a collective myth.

Through a semiotic analysis of *Joker*, this study demonstrates how the film's symbolic imagery serves as a powerful narrative tool, reflecting the protagonist's psychological state and the oppressive societal forces at play. The use of icons, indices, and symbols not only deepens the audience's understanding of Arthur Fleck's transformation but also critiques broader issues such as mental health stigmatization and societal inequality. Ultimately, *Joker* illustrates how visual storytelling, when dissected through a semiotic lens, offers rich insights into the complex dynamics between individual identity, societal pressure, and violence. At its core, *Joker*'s symbolic language serves as a metanarrative addressing the dilemmas of modernity. Peirce's theoretical framework elucidates how the film intricately orchestrates a system of signs to transform personal psychopathology into a societal critique. In this context, the fissures in the Joker's makeup are not merely cosmetic imperfections but symptoms of a collapsing symbolic order, visually manifesting the crisis of subjectivity in the post-truth era. He epitomizes an anti-hero forged by symbolic violence, ascending as a cultural totem of our times.

This essay offers a systematic visual-semiotic framework for decoding films. By foregrounding mise-en-scène components such as lighting, composition, costume, gesture, and so on as lively signs, this approach reveals layers of meaning that standard narrative analysis would possibly overlook. The method is adaptable to other films or visual media where imagery becomes a primary discourse. At the same time, this undergraduate study is preliminary in scope. It specializes in visual signs and symptoms without claiming to exhaustively explain the movies' narratives or sociopolitical contexts. Future studies could build on this work through incorporating different cinematic theories or examining how target audience reception interacts with visible symbolism. Overall, the visual-semiotic reading presented here demonstrates that *Joker*'s imagery is not incidental. Each sign contributes to the film's critique of social decay and alienation. By carefully attending to visual details in *Joker* and its sequel, this thesis shows in a modest but meaningful way how films can communicate ideas beyond words, thereby enriching our understanding of cinematic storytelling.

References

- [1] Arenas, A., Camacho, J., Cuesta, J. A., & Fortuny, J. M. (2011). The Joker effect: Cooperation driven by destructive agents. *Journal of Theoretical Biology*, 279(1), 113–119. <https://doi.org/10.1016/j.jtbi.2011.03.017>
- [2] Brooker, W. (2002). Batman unmasked: Analysing a cultural icon. *Australian & New Zealand Journal of Psychiatry*, 36(6), 834–835. <https://doi.org/10.1046/j.1440-1614.2002.t01-4-01121.x>
- [3] Driscoll, R., & Husain, S. (2021). Commentary on *Joker* and mental health. *Psychology Today*, 189–194.
- [4] Freud, S. (1920). General introduction to psychoanalysis. *The Journal of Nervous and Mental Disease*, 52(6), 548–549. <https://doi.org/10.1097/00005053-192012000-00047>
- [5] Friedberg, M. (2020). Interview with production designer: The look of *Joker*. *Filmmakers Academy*, 100–105.
- [6] Harman, G. (1977). Semiotics and the cinema: Metz and Wollen. *Quarterly Review of Film Studies*, 2(1), 15–24. <https://doi.org/10.1080/10509207709391329>
- [7] Johansen, J. (1993). *Dialogic semiosis: An essay on signs and meaning*. Indiana University Press. <https://doi.org/10.2979/1512.0>
- [8] Lacan, J. (1977). *Écrits: A selection* (A. Sheridan, Trans.). W. W. Norton & Company.
- [9] Lubis, A. Y., & Oisina, I. V. (2022). Discursive symbolism in a semiotic approach on the *Joker* movie trailer. *EduLite Journal of English Education*, 19(1), 121–138. <https://doi.org/10.24002/jik.v19i1.3493>
- [10] McCartney, P. (2021). We three. On *Kisses on the bottom* [Album]. Capitol Records.
- [11] Nierenberg, A. (2021). Cinema and stigma: The *Joker*'s ethical questions. *BJPsych Bulletin*, 45(6), 185–190.
- [12] Nietzsche, F. (1961). *Thus spoke Zarathustra* (R. J. Hollingdale, Trans.). Penguin Books.
- [13] Palaver, W. (2012). The *Joker* is Satan. *The Bulletin of the Colloquium on Violence & Religion*, 41, 13–15.

- [14] Peirce, C. S. (1934). *Collected papers of Charles Sanders Peirce* (C. Hartshorne & P. Weiss, Eds.). The Belknap Press of Harvard University Press.
- [15] Qiao, X. (2021). *An analysis of the protagonist's personality structure in the film Joker from the perspective of Freudian theory* [Master's thesis, Guilin University of Technology]. (Original work published in Chinese: 乔心怡: "从弗洛伊德理论视角解析电影<小丑>主人公的人格结构")
- [16] Shepherd, S. M., Delgado, R. H., Sherwood, J., & Paradies, Y. (2017). The impact of indigenous cultural identity and cultural engagement on violent offending. *BMC Public Health*, 18(1), Article 818. <https://doi.org/10.1186/s12889-017-4603-2>
- [17] Sher, L. (2020). Interview with cinematographer. *Filmmakers Academy*, 85–95.
- [18] Uysal, Y. (2023). Joker: Film, working class and post-truth. *CINEJ Cinema Journal*, 11(2), 390–405. <https://doi.org/10.5195/cinej.2023.587>
- [19] Sun, Z. (2021). *A study on the symbolic construction of the Joker image in DC comic adaptation films* [Master's thesis, Qufu Normal University]. (Original work published in Chinese: 孙正瑞: "DC 漫改电影中小丑形象的符号化建构研究")
- [20] Wu, B. (2023). An analysis of nonverbal signs in the film Joker. *Youthful Years*, (2), 41–43. (Original work published in Chinese: 武博文: "浅析电影<小丑>中的非言语符号")
- [21] Zhang, R. (2023). *The joys and sorrows of life* [Master's thesis, Jingdezhen Ceramic University]. (Original work published in Chinese: 张蓉: "生命的悲欢")

Copyrights

Copyright for this article is retained by the author(s), with first publication rights granted to the journal.

This is an open-access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/4.0/>).