ORIGINAL ARTICLE

ORBIS Litterarum **WILEY**

On the realist aesthetics of digital de-aging in contemporary Hollywood cinema

Kathleen Loock 🆔

Leibniz University Hannover, Hannover, Germany

Correspondence
Kathleen Loock, Leibniz University Hannover, Hannover, Germany.
Email: Kathleen.Loock@engsem.uni-hannover.de

This essay examines digital de-aging—a process of making actors appear younger on-screen than they actually are that has taken a firm hold in contemporary Hollywood cinema—as a controversial filmmaking tool that raises fundamental questions about cinematic realism in the digital age. Since Hollywood's visual effects are similar to the image manipulation that can be achieved with deepfake software, digital de-aging is framed as a complex creative process that supports the actors' craft in order to distinguish it from the image manipulation and misinformation that has come to characterize the post-truth era. I will discuss the affordances and limitations of Hollywood's "youthification" technology in terms of the shifting ontologies that characterize the transition from the photographic to the digital image, situate digital de-aging within larger debates about synthespians and the realistic portrayal of digitally created human beings, and argue that de-aging in films such as *Gemini Man* (Ang Lee, 2019) and *The Irishman* (Martin Scorsese, 2019) reconfigures linear temporalities and ultimately reshapes the concepts of time and memory by which we structure our life trajectories.

KEYWORDS
digital de-aging, Hollywood cinema, memory, realism, visual effects

1 | INTRODUCTION

The science fiction thriller *Gemini Man* (Ang Lee, 2019) stars 51-year-old actor Will Smith and a 23-year-old version of himself. Smith plays retired government-sanctioned assassin Henry Brogan, who is chased by a clone named Junior. This character, Junior, is the stuff of science fiction—not only on the level of plot. Junior is a fully digital creation, a de-aged Will Smith consisting of pure data derived from a process of recording the actor's movements and facial expressions that was mapped onto a digital model and then painstakingly altered based on stills and clips from Smith's performances in the early- to mid-1990s so as to achieve the desired rejuvenation effect. At a screening of the movie, Will Smith joked about the future use of his data and how he would no longer need to stay in shape: "There's a completely digital 23-year-old version of myself that I can make movies with now. […] I'm gonna get really fat and really overweight" (quoted in King, 2019). Whether we are heading towards a future of "synthespians,"[1] "cyberstars," or "vactors" (virtual actors), in which "living actors may compete with digital images for the major roles in the latest blockbuster or romantic comedy," as Barbara Creed speculated already 20 years ago (Creed, 2000, 79, 80), remains to be seen. One thing is certain, however: digital de-aging, the process of making actors appear younger on-screen than they actually are, is becoming the new normal in Hollywood.[2]

First experimentations with computer-generated youthfulness can be found in a flashback scene of *X-Men: The Last Stand* (Brett Ratner, 2006) and, already much more refined, in *The Curious Case of Benjamin Button* (David Fincher, 2008). But it was the belated science fiction sequel *TRON: Legacy* (Joseph Kosinski, 2010) about a video-game developer who is trapped in cyberspace that pushed the boundaries of digital de-aging. In the film, 60-year-old actor Jeff Bridges plays opposite his digitally rejuvenated self who looks like the 32-year-old Bridges from *TRON* (Steven Lisberger, 1982). Since then, de-aging has become an increasingly more convincing and, overall, more common visual effect in the digital—or: post-cinematic—era. From Orlando Bloom as unaging Elf Legolas in *The Hobbit: The Desolation of Smaug* (Peter Jackson, 2013) to Arnold Schwarzenegger in *Terminator: Genisys* (Alan Taylor, 2015) to Johnny Depp's Jack Sparrow in *Pirates of the Caribbean: Dead Men Tell No Tales* (Joachim Rønning and Espen Sandberg, 2017): mostly male actors are getting a digital facelift that erases their real age and chronology.

Gemini Man was released in 2019, when digital de-aging had become so prevalent that critics spoke of "a monumental year for de-aging in film" (Kemp, 2020), "a year haunted by the digital phantoms of movie stars as they once looked" (Dowd, 2019), and the year when "Hollywood has become unstuck in time" (Breznican, 2019). *Gemini Man* along with another five blockbusters—*Captain Marvel* (Anna Boden and Ryan Fleck, 2019), *Avengers: Endgame* (Joe and Anthony Russo, 2019), *It Chapter Two* (Andrés Muschietti, 2019), *Star Wars: The Rise of Skywalker* (J. J. Abrams, 2019), and *The Irishman* (Martin Scorsese, 2019)—de-aged their stars. They did so with the help of visual effects companies, which have perfected their different techniques over the last years, including "digital cosmetics" to smooth out wrinkles and remove blemishes with patches, blurs, glows, and digital paint, as well as tracking markers, scans, CGI (computer-generated imagery) models, performance capture technology, and reference material from past performances that is combined with the new footage. The increasingly realist aesthetic of digital de-aging has been lauded as a breakthrough for visual effects technology as well as for storytelling. It has proven to solve narrative problems with rules about time and time travel in the Marvel Cinematic Universe[3] and made it possible to realize the science-fiction premises of movies like *TRON: Legacy*, *Terminator: Genisys*, and *Gemini Man*, where time warps and cloning drive the plots. Digital de-aging has also been used to tell decades-spanning epics such as *The Irishman* that center on the long-term development of (aging) characters, without using layers of make-up, prosthetics, or casting different (i.e. younger) actors in the same roles. Advocates of the practice have pointed out how de-aging supports the suspension of disbelief as it allows the creation of less disruptive links between the past and the present.

More skeptical observers of the trend, however, have expressed their fears about the legal implications of digital de-aging technology and the data it amasses. While de-aging might diminish prospects for young actors to land a breakout role, it also fails to create more roles for older stars—especially female actors—and effectively

sanctions ageism in the film industry by erasing the signs of age. In the post-truth era, there are also worries about the gray area in which Hollywood's de-aging efforts and inexpensive, accessible deepfake software (that uses machine-learning algorithms to manipulate visual and audio content of pornographic or political clips) seem to converge, arguing that "the drive to fool the viewer is the same" (King, 2019). Most notably, there is disagreement about whether the technology has sufficiently advanced so that de-aging does not have an "uncanny valley" effect. In 1970, Japanese roboticist Masahiro Mori introduced the term "uncanny valley" to describe the moment in which human responses to artificially created humans (i.e. humanoid robots) shift from empathy to eeriness and revulsion (Mori, 2012). If the objects become too lifelike, they are no longer convincing but uncanny. They are strangely familiar and at the same time unsettling because their familiarity is so difficult to process and to understand within the framework of the world we know. Digital de-aging, with its manipulation of human faces and body movements, certainly runs the risk of tumbling down into the uncanny valley. Considering the digitally edited faces of Robert De Niro, Al Pacino, and Joe Pesci in *The Irishman*, for instance, director Martin Scorsese expressed worries about what he calls the "youthification" (quoted in Rose, 2019) of actors he has known and worked with all his life. Actually, the movie had to be delayed because Scorsese thought that the technology was not there yet, that it was still not convincing enough (Rose, 2019).

Digital de-aging is supposed to be an *invisible* effect in the service of unprecedented realism. Yet, despite the high degree of verisimilitude digitally rejuvenated faces have achieved in Hollywood, something seems to be off with "youthified" versions of familiar actors on-screen that threatens to disturb audiences and cause discomfort. The uncanniness of a de-aged Will Smith or Robert De Niro can be located in the occasional weird sheen on their altered features as well as in the unnatural movements that either seem too smooth (in the case of *Gemini Man*) or belong to an elderly, less intense actor rather than the one that digital de-aging technology has created (in *The Irishman*). The eerie sensation extends beyond the screen and affects not only how we remember the younger Will Smith or Robert De Niro, but also how we remember ourselves and our own chronologies. This essay examines digital de-aging as a controversial filmmaking tool that raises fundamental questions about cinematic realism in the digital age. I will discuss the affordances and limitations of Hollywood's "youthification" technology in terms of the shifting ontologies that characterize the transition from the photographic to the digital image, from the cinematic to the post-cinematic, situate digital de-aging within larger debates about synthespians and the realistic portrayal of digitally created human beings, and argue that de-aging in films such as *Gemini Man* and *The Irishman* ultimately reshapes our concepts of time and memory.

2 | CINEMATIC REALISM IN THE DIGITAL AGE

The rise of digital imaging technologies has led to a crisis in film theory. Computer-generated imagery challenges the idea of cinema as a photographic medium and questions assumptions about cinematic realism based on the indexicality between the photographic image and its referent. Digital de-aging must be examined within this ongoing debate. Traditionally, film has been theorized as a medium that reproduces photographic recordings of a profilmic reality. Images establish an indexical relationship to referents in the physical world before the lens. Accordingly, the concept of cinematic realism, as staked out by theorists like Siegfried Kracauer, André Bazin, and Stanley Cavell, "is rooted in the view that photographic images, unlike paintings or drawings, are indexical signs: they are causally or existentially connected to their referents" (Prince, 1996, 28). For most of the twentieth century, cinema's analog heritage and indexicality have dominated debates about realism. Lev Manovich explains:

> [...] behind even the most stylized cinematic images we can discern the bluntness, the sterility, the banality of early 19th-century photographs. No matter how complex its stylistic innovations, the cinema has found its base in these deposits of reality, these samples obtained by a methodical and prosaic process. Cinema emerged out of the same impulse that engendered naturalism, court

stenography, and wax museums. *Cinema is the art of the index*; it is an attempt to make art out of a footprint.

<div align="right">(Manovich, 2016, 21; emphasis added)</div>

Digital imaging processes, which have radically reconfigured filmmaking since the 1990s, and the shift from cinema to post-cinema in the twenty-first century break with the concept of indexicality and indexically-based notions of cinematic realism. In the digital age, Manovich observes, "the production becomes just the first stage of post-production" (p. 29). Digital images can be fabricated, manipulated, modified, and edited to create photorealistic scenes that have never actually been filmed. Dan North writes that "[t]o produce a digital representation of an object, whether or not it has a real-world referent, is to remove the element of *indexicality*, the direct relationship between the image and its source" (North, 2008, 17; emphasis in original). Digital images, in other words, lack photography's indexical connection to the physical world but they mimic the look of photography, along with its indexicality. "The computer-generated object is a creation whose physical presence bears no resemblance to what it signifies—it is merely a quantity of data in a microchip—but when transferred to its imagistic form, it can be rendered with such photographic verisimilitude that it can *appear to be* an index of its referent" (p. 17; emphasis in original).

The fact that digital images no longer have to correspond to real-life referents has caused ontological anxieties and a distrust of the image, of its manipulation and fabrication, and, more generally, of deception and erasure. To be sure, early film theorists like Rudolf Arnheim, Dziga Vertov, and Sergei Eisenstein already pointed to "cinema's capacity for reorganizing, and even countering and falsifying, physical reality" (Prince, 1996, 30). In that sense, digital images only showcase cinema's investment in creating illusions and simulating reality. Yet photographic realism remains an aesthetic ideal in the digital age. That is why it is common to use CGI effects to simulate the photographic process. The addition of digital lens flares in superhero movies like *The Green Lantern* (Martin Campbell, 2011), *Star Trek* (J. J. Abrams, 2009), and Michael Bay's *Transformers* series (2007–2017), for instance, "emphasizes the plastic reality of 'profilmic' CGI objects" (Denson, 2016, 198). But, as Shane Denson writes, such lens flares also "[highlight] the images' artificiality by emulating (and indeed foregrounding the emulation of) the material presence of a (non-diegetic) camera" (p. 198). Another example of CGI-generated "flaws" designed to reduce the difference between digital and photographic images and to heighten cinematic realism is artificial motion blur. Because the computer-generated dinosaurs in *Jurassic Park* (Steven Spielberg, 1993) have motion blur just like the live-actors that appear in the same scene, they come across as more realistic, more life-like in their movements than the miniature models and stop-motion creatures of earlier films that lacked motion blur (cf. Prince, 2012, 34). North is right, when he suggests that "[t]here is a paradox here in the way that the digital replaces the indexical but imitates those properties of the photographic image which signal its indexicality" (North, 2008, 20). However, for purposes of cinematic realism and what audiences expect that cinematic realism to be, clinging to the photographic past of the medium seems to make perfect sense.

Given the proliferation of both virtually invisible digital effects and spectacular visual creations, Stephen Prince has proposed the term "perceptual realism" to account for the reconfiguration of indexicality as the basis of cinematic realism in the digital age and to adequately describe images that are "perceptually realistic but referentially unreal" (Prince, 1996, 34). Perceptual realism, as Prince defines it, depends on contextual cues about light, texture, and movement that serve "as a means for anchoring the scene in a perceptual reality that the viewer will find credible because it follows the same observable laws of physics as the world s/he inhabits" (Prince, 2012, 32). For instance, even though *Jurassic Park*'s dinosaurs do not exist in the real world, "the perceptual information they contain is valid" and they "acquire a remarkable degree of photographic realism" (Prince, 1996, 34). The effective blend of animatronics and digital animation that seamlessly fits the pre-historic creatures into the live-action scenes, "fooled [no one] into thinking that dinosaurs were actually alive, but because digital tools established perceptual realism with new levels of sensory details, viewers could be sensually persuaded to believe in the fiction and to participate in the pleasures it offered" (Prince, 2012, 33). The impression of realism becomes uncoupled from photography's indexicality, as the example of Steven Spielberg's dinosaurs

shows: "indexical referencing is no longer required for the appearance of photographic realism in the digital image" (Prince, 1996, 32–33).

The general suspicion associated with the digital age is ultimately both fueled and counterbalanced by cinema's "photorealistic" CGI and the impression of perceptual realism that digital tools are able to produce. They can create "new extensions of realism and fictional truths," Prince (2012, 53) contends, when they achieve an organic combination of the synthetic and the real, and a digital construction of characters, objects, and spaces that, if placed side-by-side, are perceptually indistinguishable from characters, objects, and spaces in the physical world. From spectacular creatures like *Jurassic Park*'s T-Rex, Godzilla, and King Kong to fantastic characters like Gollum in *The Lord of the Rings* and the blue Na'vi in *Avatar* (James Cameron, 2009) to life-like digital human beings such as CLU in *Tron: Legacy*, Rachael in *Blade Runner 2049* (Denis Villeneuve, 2017), and, most recently, Junior in *Gemini Man*, cinema's visual effects have never seemed so real. While digital characters tend to draw attention to themselves and to cinema's capacity for producing such visual spectacles, this self-reflexive operational aesthetic is entirely missing from invisible effects. Invisibly manipulated images look as if they were filmed (not like the result of post-production techniques) and they are meant to go unnoticed by the viewers. There are the digitally created crowds in the opening scene of *Titanic* (James Cameron, 1997) and the computer-generated, visible breath of the passengers floating in the ice-cold water after the ship sank, for example. *Detroit* (Kathryn Bigelow, 2017), a film about the 1967 Detroit riots and the persistence of systemic racism in the United States, uses CGI to recreate specific locations of the time, like the Algiers Motel and the Great Lakes Mutual Life Insurance building. Explosions in the war epic *1917* (Sam Mendes, 2019) are computer-generated and its single-take style is manufactured from various shots that are invisibly stitched together so that the film appears to unfold in one continuous shot. Invisible and seamless visual effects have become Hollywood's go-to solution when filming is too costly or too difficult.

Digital de-aging occupies a strange middle ground between the visible and invisible visual effects that have become so common in contemporary cinema. On the one hand, "youthification" processes that blend computer-generated images and motion capture to create dazzling images of seemingly ageless actors invariably evoke interest in *how* this feat was pulled off.[4] On the other hand, digital de-aging is intended to be invisible and facilitate the viewers' immersion in the story. Perceptually realistic images of de-aged actors like Will Smith and Robert De Niro exemplify the ontological conundrum that "youthifying" popular actors entails. Digital recreations of their younger selves serve to tell the life story of Frank "The Irishman" Sheeran (Robert De Niro), a truck driver who becomes a Mafia hitman and works for labor union boss Jimmy Hoffa (Al Pacino), and a cautionary tale of science gone wrong, in which Henry Brogan must confront his younger doppelgänger. De-aging, in other words, supports the cinematic realism of the fictional worlds created on-screen. Yet, the digitally created youthful versions of these two actors do not correspond to the real-life younger selves of the actors as they are recorded in earlier films and familiar to audiences. Smith and De Niro were already Hollywood stars when they were younger so that seeing them digitally rejuvenated has an unsettling effect. There is a discrepancy between the remembered past and the past as it is now reconstructed on-screen. Yet, because of the strides that digital tools have made, the "youthified" actors seem so realistic that what we know about their indexicality, the underlying real-world referents of the image, is being called into question. This is where the perceptual realism digital de-aging technologies have been able to achieve enters critical debates about synthespians and ontological anxiety, and where it clashes with concepts of time and memory.

3 | SYNTHESPIANS AND ONTOLOGICAL ANXIETY

As Dan North points out, much of the critical work on the synthespian has been speculative (North, 2008, 154). Barbara Creed's discussion from the year 2000, for instance, predicts that "[a]lthough a film, animation aside, has not yet been made with a computer-generated or virtual film star in the main role, this appears to be the future" (Creed, 2000, 80). In 2008, North finds "theorists are so caught up in the imminence of the arrival of digitized

humans and the ontological repercussions that the question is never raised as to why it seems so definite in the first place" (North, 2008, 155). He is skeptical about whether "there [is] any use for synthespians in lead acting roles other than for the technological novelty value," and argues that "the synthespian represents a contemporary manifestation of the Frankenstein myth, embodying our own fear of replication and obsolescence, our replacement by digital constructs capable of outstripping our every capability and nuance" (p. 155). Early in the new millennium, the idea of a synthespian playing the main character in a live-action film was itself the stuff of speculative fiction: *S1m0ne* (Andrew Niccol, 2002) is a film about a director, Viktor Taransky (Al Pacino), who replaces his difficult star (Winona Ryder) with a virtual actor called "Simone." Tellingly, the computer-generated actor, who becomes a sensation overnight, was played by real-life actor Rachel Roberts. But *S1m0ne* nonetheless addresses fears that Hollywood will replace human film stars with post-human entities made of pixels, rendered by computer code and algorithms. Writing in 2012, Stephen Prince dispels such worries by pointing to the hybrid performance modes used to create characters like Gollum, Benjamin Button, and the Na'vi: visual effects tools, his argument goes, create digital extensions of traditional costumes, masks, or elaborate prosthetic makeup that support the live-actor's craft rather than making it obsolete (Prince, 2012, 142–143). Prince is convinced that "the live performer remains as important as ever" in the digital age, which "offers new stages on which an actor might perform characters and new ways of visualizing performance" (pp. 143, 144).

So far, the synthespians we encounter in the cinema have little in common with "Simone." They tend to have the familiar faces of stars audiences already know and love, which, in turn, shifts fears that real-live actors will eventually be replaced by synthespians that have no living or real-world referent to more urgent ethical, legal, and ontological concerns. Deceased actors have been digitally resurrected after their unexpected deaths—for instance, Brandon Lee, who passed away during the filming of *The Crow* (Alex Proyas, 1994), and, more recently, Paul Walker, who died during the production of the seventh installment of the *Fast & Furious* franchise, *Furious 7* (James Wan, 2015)—and if their role was deemed crucial for the serial unfolding of long-running franchises—Peter Cushing (who passed in 1994) returned as Grand Moff Tarkin in *Rogue One: A Star Wars Story* (Gareth Edwards, 2016), for example, and Carrie Fisher (who passed in 2016) as Princess Leia in *Star Wars: The Rise of Skywalker*. Such resurrections raise moral and philosophical questions about the rights of the dead over the posthumous uses and commercial exploitation of their likenesses, about legacies, consent, and restrictions, and about how stars will be able to shape their digital afterlives (Stadler, 2019). In 1999, California state legislature passed what is popularly referred to as the "Astaire Bill" (Senate Bill 209) limiting the use of images of deceased actors without the consent of their heirs. The widow of Fred Astaire (who died in 1987), Robyn Astaire, had pushed for the legislation after computer-generated images of her husband had been used to sell condoms and vacuum cleaners (Logan, 1999; Creed, 2000, 81).

In comparison to such digital resurrections, the creation of youthful digital doubles of aging actors is something else entirely because the actors are part of the process. Body and facial scans amass huge amounts of data that can then be used for computer modeling. Still, doubts about the future use of the youthful doppelgängers remain. Sean Young, who was involved in creating an unaged, digital version of her character Rachael from *Blade Runner* (Ridley Scott, 1982) for the 2017 sequel *Blade Runner 2049*, belongs to the few female actors who have received Hollywood's de-aging treatment. She returns for a scene with Harrison Ford who reprises his role as Rick Deckard. In contrast to Young, his face and body are allowed to show the years that have passed between both films, or, as *Vulture*'s Nate Jones (2017) summarizes Hollywood's double standard: "Male stars get to age, while women live on in digital re-creations of their younger selves." Although the actors that have been de-aged in recent years were predominantly men, their aged counterparts usually appear in the films as well. Female stars, however, need to remain frozen in time and youth. In order to de-age Sean Young, the British visual effects studio Moving Picture Company (MPC) scanned the form of her skull to make a digital model of Rachael's head, which was then combined with footage and images of Young from the 1980s. The digital head was later grafted onto stand-in actor Loren Peta and another actor was hired to re-create Young's voice. Young worried about the legal implications of this process and wondered what would happen if the production company "wanted to create an

entire show with me, or just use my image in any way whatsoever, the technology exists. [...] I must trust whom-ever has my image to behave respectfully. Do I have any rights? Or even if it was acknowledged that I had rights, could I enforce them?" (quoted in Trenholm, 2017). And Will Smith might have been joking about the fact that the digital 23-year-old version of himself created for *Gemini Man* can play roles for him in the future, but it is indeed a possibility that Junior returns to the big screen, which, once more, leads to the pressing question of who owns the de-aged, or resurrected, digital selves. Apparently, Smith has secured the rights for Junior, but it is not clear who owns the data used to build Junior that is stored with the New Zealand-based digital effects company Weta Digital (Li, 2019). As one observer points out, "performers will have to start being vigilant about safeguarding the rights to their image if they submit to a scanner" (King, 2019).

Only the future can tell whether de-aging technologies will change acting forever, as some critics are specu-lating at the moment (Breznican, 2019). As visual effects companies are synthesizing youthful versions of famous stars, they do not only liberate the actors from time itself, but they also pave the way for a line-up of familiar-looking synthespians, if actors decide to license their likenesses to perform forever. In a Netflix special feature that has Martin Scorsese, Robert De Niro, Al Pacino, and Joe Pesci talk about the production of *The Irishman*, De Niro weighs in on the impact de-aging technology might have on the longevity of the aging men's careers, predicting that, "We'll all be able to act for another 30 years" (Netflix, 2019b). If this is going to be our future will certainly depend on whether digital de-aging serves storytelling purposes or is a spectacle that disrupts the audi-ences' suspension of disbelief, on how *real* "youthified" characters look on-screen, and on whether the technology delivers perceptually convincing images or pushes a film into the "uncanny valley." Digital de-aging that draws on photographs, footage, and performance capture techniques seeks to bridge "a disconcerting gulf between the an-imate, living human and the inanimate, unliving digital" (Stadler, 2019, 131). It designs false, yet eerily familiar faces that get so close to being real that they might no longer be convincing but become strange and uncomfortably unnerving. Which brings us back to the ontological anxiety associated with the digital image.

Since the advent of CGI, creating lifelike digital human beings has been considered the "Holy Grail" by visual effects artists. A major challenge of the digital project was the photorealistic rendition of the human face. "Partly the problem is a function of its complexity," writes Prince (2012, 122): the face contains 53 muscles that are not attached to bones or joints and can therefore not be adequately captured as vertex data (pp. 122–123). As a result, the information of the digital face tends to be incomplete and can cause audiences to feel an emotional disruption. Since digital de-aging is first and foremost about the "youthification" of the face, it is crucial that the images achieve a high level of perceptual realism. One method to meet that goal is the employment of digital head replacements, which the US-based visual effects company Digital Domain used for Brad Pitt's Benjamin Button as well as for Jeff Bridges in his role as *TRON: Legacy*'s never-aging villain CLU, and with which MPC created Sean Young's Rachael in *Blade Runner 2049* as well as Arnold Schwarzenegger's T-800 in *Terminator: Genisys*. Lola VFX, which handled the "youthening" effects in *The Curious Case of Benjamin Button*, has specialized in "digital cosmet-ics" that are applied in post-production, a method that has been predominantly employed to erase time from the faces of actors portraying Marvel characters. During filming, makeup and lighting are strategically used to make the actors look as youthful as possible and markers capture their facial and body movements. In post-production, "visual-effects artists erase the markers and apply patches of 'skin' onto the photographed performance, calibrat-ing them frame by frame" (Li, 2019). For *The Irishman*, Industrial Light & Magic (ILM) developed a de-aging technol-ogy that worked without markers because the stars did not want dots, helmets, or bodysuits to interfere with their acting. Instead, they were filmed by a three-camera rig (called the "three-headed monster") with the "director" camera at the center and two "witness" cameras on either side that shot infrared footage and harvested the nec-essary data to recreate the performance digitally (Breznican, 2019; Kemp, 2020; Li, 2019). The most sophisticated de-aging process to date is probably Weta Digital's creation of Junior for *Gemini Man*. It involved scanning Will Smith, compiling a database, making a digital replica, rejuvenating the replica based on stills and footage from the actor's early career, and finally animating the digital version with even more digital information derived from Smith's performance on a motion-capture stage (King, 2019).

Detailed technical information about the various de-aging processes that are currently being used in Hollywood is freely available and often part and parcel of the films' marketing campaigns and press coverage. With regard to the creation of Kong in Peter Jackson's remake *King Kong* (2005), Tanine Allison (2011) has identified a similar interest in explaining to audiences how the technology behind the digital characters works, in visualizing the invisible off-screen operations that are necessary to produce a degree of perceptual realism that allows viewers to stay immersed in the fictional world on-screen. The abundance of material that gives audiences unprecedented access to behind-the-scenes work establish a meta discourse about cinematic realism in the digital age by foregrounding "how the digital process creates a recording of real-world activity" (Allison, 2011, 338). According to Allison, "[t]his link to a referent in our lived reality may serve to calm anxieties about the possibility of digital simulation supplanting filmic, or physical, reality" (p. 338). In the case of digital de-aging, a broad range of paratexts frame the uncanny mastery of chronological time as the result of an indexical process that depends on actual referents in the physical world and, most importantly, on the performances of real-life actors rather than the manipulation of data and pixels. Or, as the Netflix featurette "How *The Irishman*'s groundbreaking VFX took anti-aging to the next level" puts it: "[...] as with every innovation in film, the technology is only as powerful as the performances that push the story forward" (Netflix, 2019).

Such discourses present the actors' craft not only as a (if not *the*) central ingredient of cinema but also as something unequivocally real (and realistic) that is not getting lost among visual effects but is, quite on the contrary, radically enhanced by digital de-aging tools. Precise accounts of the off-screen work involved in rejuvenating the faces of familiar stars, in other words, are carefully designed to encourage the audiences' appreciation of the groundbreaking (yet, ideally, invisible) de-aging effects against a baseline of cinematic realism established by actors and their performances. Laying out the filmmaking process in this way provides ontological cues for audiences, instructing them how to make sense of what they see on-screen. This approach certainly breaks "with older traditions of realism that sought to keep the production apparatus invisible" and "[deemed] deception [...] necessary to protect the fantasy created onscreen," as Allison (2011, 325–326) contends. But it serves to reaffirm the persistence of indexicality in the digital age and fosters trust in the "truth" of the digital image. The paratexts communicate that real actors, directors, producers, writers, film crews, visual effects artists, and post-production teams have been involved in making these films. In the post-truth era, establishing digital de-aging as something that is genuinely "true" (not "fake"), that might even be necessary to tell a story with the right amount of realism, is clearly meant to distinguish Hollywood's "youthification" trend and high-end effects from the AI-driven deepfake technology that morphs images of celebrities or public figures onto unrelated clips (predominantly pornographic videos but also political speeches). The discourse surrounding digital de-aging asserts that both its process and purpose are opposed to deepfake's videos and the misinformation they spread. And yet, I argue that digital de-aging cannot fully escape the impression that its images, too, are fabricated and that the rejuvenated faces it produces end up manipulating our concepts of time and memory.

4 | RESHAPING TIME AND MEMORY

In a *Wired* piece, critic Darryn King writes about *Gemini Man*: "As sophisticated as motion capture is, and despite the massive trove of measurements taken of Smith's every gesture and movement, it still cannot record the full richness and depth of human behavior—the subcutaneous subtleties and minute movements, the microexpressions, the difficult-to-pinpoint qualities that comprise humanness" (King, 2019). For King, Will Smith's youthful digital doppelgänger ultimately remains a lifeless creation. While the effect of seeing Henry Brogan face off against the younger version of himself is remarkably convincing in a dimly lit fight scene in the catacombs of Budapest, for instance, there are moments in the film when Junior lacks perceptual realism—because his movements are too fast and smooth, and, most notably, in the final scene that has the characters walking on a college campus in broad daylight. *Los Angeles Times* critic Justin Chang (2019) finds that even if the "younger clone *should* look a little

off, a little CGI [...] it remains an empty, off-putting stunt, and not a particularly moving one." Of course, *Gemini Man*'s science fiction premise comes with built-in philosophical and ethical questions about the consequences of scientific progress (human cloning to create perfect soldiers) that pit human empathy against cold rationality (or: emotional emptiness). At one remove, however, the cutting-edge visual effects are not only designed to tell the story in a convincing way. They also comment on the film's theme, enacting the conflict of the two poles (empathy and rationality) in a decidedly self-reflexive manner: Junior (standing in for the progress in digital de-aging and visual effects technology) lacks the emotional depth of Henry Brogan (played by the aging Will Smith audiences know and remember), who, full of pain and self-loathing, regrets his life choices.

In the *A.V. Club*, A. A. Dowd (2019) goes a step further, suggesting that "*Gemini Man*'s cloning-gone-wrong plot also doubles—pun neither intended nor avoided—as a cautionary tale about the folly of trying to resurrect that younger Will Smith in the first place." In the critical piece that argues the film "uses de-aging technology to make a case against de-aging technology," Dowd (2019) also asks: "what are we really seeing but a middle-aged Will Smith confront his own movie-star legacy, his own past as a more 'perfect' physical specimen and marquee attraction?" I contend that the film's visual effects—juxtaposing old and young in the same image—are more than an action-laden Turing test or a navel-gazing exercise. Digital de-aging draws attention to the passing of time, while simultaneously erasing its effects; it calls up memories of the familiar stars' younger selves that never quite match the digitally rendered images; it turns back the clock for—predominantly male—actors with regard to their looks but it cannot do the same for their performances. In *Gemini Man*, Will Smith is "acting his age" (Dowd, 2019) and, then again, he is not. The young, muscular Junior is nothing like the lanky, mustache-wearing 23-year-old Will Smith audiences know from the 1990s sitcom *The Fresh Prince of Bel-Air* (NBC, 1990–1996). He remains what Dowd (2019) calls "an artificial approximation of the 'original' Will Smith." "The unnerving unreality of Junior, a special effect that never quite acquires a soul," he writes, "[...] implies that no matter how good the technology gets, there's no way to really bottle or resurrect the lightning charisma of a star in their prime" (Dowd, 2019).

Similar observations have been made in connection with *The Irishman*, where the digitally de-aged version of 76-year-old Robert De Niro *looks* young but fails to *act* young. It is a two-fold problem involving time and memory. First, *The Irishman* limited de-aging effects to the actors' faces, working without digital head replacements on the bodies of actors, who might have performed the physical movements of the younger Frank Sheeran more convincingly than De Niro himself (a technique used in *The Curious Case of Benjamin Button* to portray Brad Pitt's character from his eighties to his late sixties; Prince, 2012, 137). In a *Vulture* piece, Bilge Ebiri points out that De Niro "was an actor with a mythically powerful physical presence," but has "lost that versatility of movement, which has softened his unpredictability and intensity" as he has grown older (Ebiri, 2019). There is a scene set in the 1950s, in which a 30-something Frank Sheeran beats up the neighborhood grocer because he accidently shoved Sheeran's daughter. A de-aged De Niro walks his daughter over to the grocery store so that she can witness him violently attacking the owner, stomping repeatedly on his hand as he lies on the ground. But De Niro's stomping is awkward, his body movements seem off. In the *New York Times Magazine*, Nitsuh Abebe explains that:

> [i]t's not done with the swagger you'd expect from a man comfortable breaking a grocer's fingers in broad daylight. Like anyone his age, De Niro moves in a way that prioritizes stability: His elbows stay tucked protectively near his ribs, and his feet jab stiffly out without disturbing his center of gravity. It's not that he looks feeble or frail; it's just that he looks 76.
>
> (Abebe, 2019)

Face, body, and story do not add up in this much-discussed scene; rewinding time remains a utopian desire. But, then again, maybe *The Irishman*—and *Gemini Man*, too—are films about men past their prime, about aging and looking back to take stock of one's life. "*The Irishman* is best watched as a film *about* old men, and the lifetimes they have spent wrapped up entirely in one another, moving through an era that has vanished from beneath their feet," writes Abebe. "It begins to feel, as you watch, that Sheeran is *always already* an old man" (Abebe, 2019; emphasis in original).

Second, digital de-aging's reconfiguration of linear time and its chronological unfolding from youth to old age in *The Irishman* is further complicated by how audiences remember Robert De Niro. The film itself is structured along several timelines that constantly jump back and forth over the course of 50 years, showing De Niro's Frank Sheeran at different points in his life. The story is told through Sheeran's recollections of the man he used to be and what he used to do, yet those memories are difficult to accept "for an audience that remembers what a young Robert De Niro *did* look like, and sound like, and move like" (Ebiri, 2019; emphasis in original). Ebiri thinks that "the film's version of 'young' De Niro exists in this neither-here-nor-there space somewhere between youth and old age" and that this, in fact, "mimics the way memory often works: When we remember incidents from earlier in our lives, we imagine ourselves as younger versions of the people we are now, instead of the people we really were back then" (Ebiri, 2019). Recognizing the dilemma for the realist aesthetic of digital de-aging technologies, visual effects supervisor Pablo Helman sidesteps the impact on time and memory altogether, when he says: "Keep in mind that we're not looking to recreate younger versions of the actors, but rather new creations that are younger versions of the characters" (Netflix, 2019). Following this line of thought, Robert De Niro's young Frank Sheeran does not need to resemble *Taxi Driver*'s (Martin Scorsese, 1976) Travis Bickle, the eponymous *King of Comedy* (Martin Scorsese, 1982), or Jimmy Conway in *Goodfellas* (Martin Scorsese, 1990). *Gemini Man*'s Junior does not have to look like the Fresh Prince.

Such readings acknowledge that digital de-aging can easily disrupt the perceptual realism it is meant to support. Ebiri and Helman seem to explain away the cognitive dissonance that occurs with Hollywood's "youthification" by attributing it to diegetically grounded meaning-making processes (digital de-aging "mimics the way memory often works") and by imagining alternate chronologies (it is not about recreating "younger versions of the actors," but creating "younger versions of the characters"). These approaches make a lot of sense, but in order to foreground the illusion that digital de-aging helps to create, they overlook how the intricate connection between star intertextuality, audience memory, and the passing of time affects reception, and how Hollywood stars and films (and popular culture more generally) provides temporal markers that partake in structuring our life trajectories. I suggest that there is an alienating disconnect that has ultimately less to do with the technical perfection and ambitious realist aesthetics of de-aging and more to do with the ways in which the digital doppelgänger interferes with a star's intertextuality (in particular, how an actor's previous films and—*aging*—star persona determine readings of her or his performances) as well as with the memories, desires, and nostalgic longings that audiences associate with a familiar actor's actual younger self. A de-aged Will Smith or Robert De Niro, in other words, may serve Hollywood's storytelling purposes and showcase the latest visual effects wizardry, yet the discrepancy between what audiences recall about these actors and what they see on-screen may disrupt how people remember and understand *themselves* and the world in which they live. If we accept that memories shape identities and a sense of self, and that, over time, the popular culture we consume becomes thoroughly entangled with these memories, it becomes possible to see how audiences synchronize their own memories and lived experiences with Hollywood stars and their work over the course of many years and decades. Watching those familiar stars on-screen—*and watching them grow older*—helps sustain continuity and a coherent narrative between past and present selves. Digital de-aging, however, can destabilize this sense of "ontological security" (Anthony Giddens, 1991) and cause an existential crisis with regard to the temporal unfolding of self-identity. "Youthified" versions of familiar actors, in other words, produce alternate realities that challenge how we navigate time and memory.

5 | CONCLUSION

In the post-truth era, digital de-aging is a double-edged sword. On the one hand, Hollywood has made enormous strides over the last decade in terms of perfecting the technology to create perceptually realistic digital images. We do not live in the age of the synthespian, but computer-generated visual effects—like digital cosmetics and de-aging—are a common feature of contemporary Hollywood cinema. Designed to remain invisible and enhance

the realist aesthetics of a film, digital de-aging enables aging actors to play roles of younger characters in time travel scenarios, science fiction stories about cloning, and decades-spanning sagas without resorting to layers of makeup, prosthetics, or different actors. On the other hand, digital de-aging tools seem to foment the distrust of the image in the digital age. They raise urgent questions about indexicality and photographic realism, about how the images we see relate to the physical world and some notion of reality. It comes as no surprise, then, that the promotional material for films that rely heavily on digital de-aging usually includes detailed information about the de-aging process. Focusing on the craft of actors, directors, and visual effects artists and their combined efforts to achieve perceptually realistic "youthification," these production details serve to distance Hollywood's digital de-aging from the purpose and process of deepfake software. Despite such discursive strategies to establish digital de-aging as a filmmaking tool that supports the suspension of disbelief, images of familiar actors that do not correspond to their actual younger selves may have the opposite effect. Even though de-aging succeeds in avoiding the uncanny valley, it is still uncanny because it invites the simultaneous recognition that the de-aged face belongs to a familiar actor and that it is not what it resembles, that it exists without a real-life referent. As visual effects studios continue to perfect the tools and processes of digital de-aging, Hollywood will have to address ethical and legal questions and come to terms with the current gender imbalance in de-aging and the industry's dismissive attitude towards aging female stars. As for now, we can only speculate about the long-term impact of the ways in which digital de-aging reconfigures linear time and memory.

ORCID

Kathleen Loock https://orcid.org/0000-0002-5813-1324

ENDNOTES

[1] "Synthespian" is a blend of the words "synthetic" and "thespian" (actor) that was coined in the late 1980s by digital animators Jeff Kleiser and Diana Walczak (North, 2008, 148). "Synthespian" is a blend of the words "synthetic" and "thespian" (actor) that was coined in the late 1980s by digital animators Jeff Kleiser and Diana Walczak (North, 2008, 148).

[2] This article is based on my earlier, short piece "'Forever young': Digital de-aging, memory, and nostalgia" (Loock, 2020).

[3] A number of Marvel movies de-age actors in order to accommodate the MCU's complicated timeline: Michael Douglas in the role of Hank Pym in *Ant-Man* (Peyton Reed, 2015) and in *Ant-Man and the Wasp* (Peyton Reed, 2018), in which Michelle Pfeiffer, playing Pym's wife Janet van Dyne, was also de-aged; Robert Downey Jr., who plays a young version of Tony Stark in *Captain America: Civil War* (Joe and Anthony Russo, 2016); Kurt Russell in *Guardians of the Galaxy Vol. 2* (James Gunn, 2017); Samuel L. Jackson as a young Nick Fury in *Captain Marvel*; Nicole Kidman, Temuera Morrison, and Willem Dafoe are de-aged for flashback scenes in *Aquaman* (James Wan, 2018); and many cast members from *Avengers: Endgame* (Joe and Anthony Russo, 2019).

[4] Motion capture (mocap) is a technology that uses markers or trackers to record facial and body performances digitally.

REFERENCES

Abebe, N. (2019, December 31). Why the most ridiculous part of *The Irishman* actually works. *New York Times Magazine*. Retrieved from https://www.nytimes.com/2019/12/31/magazine/the-irishman-robert-de-niro.html

Allison, T. (2011). More than a man in a monkey suit: Andy Serkis, motion capture, and digital realism. *Quarterly Review of Film and Video, 28*, 325–341.

Breznican, A. (2019, December 9). *The Irishman, Avengers: Endgame*, and the de-aging technology that could change acting forever. *Vanity Fair*. Retrieved from https://www.vanityfair.com/hollywood/2019/12/the-de-aging-technology-that-could-change-acting-forever

Creed, B. (2000). The cyberstar: Digital pleasures and the end of the unconscious. *Screen, 41*, 79–86.

Denson, S. (2016). Crazy cameras, discorrelated images, and the post-perceptual mediation of post-cinematic affect. In S. Denson & J. Leyda (Eds.), *Post-cinema: Theorizing 21st-century film* (pp. 193–223). REFRAME Books.

Dowd, A. A. (2019, October 15). *Gemini Man* uses de-aging technology to make a case against de-aging technology. *AV Club*. Retrieved from https://film.avclub.com/gemini-man-uses-de-aging-technology-to-make-a-case-agai-18390 41610

Ebiri, B. (2019, September 27). So, how is the de-aging in *The Irishman*? Incredibly impressive. *Vulture*. Retrieved from https://www.vulture.com/2019/09/the-de-aging-in-the-irishman-how-bad-is-it.html

Giddens, A. (1991). *Modernity and self-identity: Self and society in the late modern age*. Polity Press.

Jones, N. (2017, October 10). Male stars get to age, while women live on in digital re-creations of their younger selves. *Vulture*. Retrieved from https://www.vulture.com/2017/10/blade-runner-2049-recreated-22-year-old-sean-young-why.html

Kemp, M. (2020, January 12). "Holy Grail" digital effects rewinding the clock for actors. *AP News*. Retrieved from https://apnews.com/43f8ed7e9a753c2191c9af7f4754bd6c

King, D. (2019, September 24). The game-changing tech behind *Gemini Man*'s "young" Will Smith. *Wired*. Retrieved from https://www.wired.com/story/game-changing-tech-gemini-man-will-smith/

Li, S. (2019, December 6). How Hollywood became obsessed with de-aging its stars. *The Atlantic*. Retrieved from https://www.theatlantic.com/entertainment/archive/2019/12/irishman-gemini-man-and-rise-de-aging/603130/

Logan, B. (1999, September 17). Things to do in Hollywood when you're dead. *The Guardian*. Retrieved from https://www.theguardian.com/film/1999/sep/17/6

Loock, K. (2020, April 6). "Forever young": Digital de-aging, memory, and nostalgia. *Flow*. Retrieved from https://www.flowjournal.org/2020/04/forever-young-digital-deaging/

Manovich, L. (2016). What is digital cinema? In S. Denson & J. Leyda (Eds.), *Post-cinema: Theorizing 21st-century film* (pp. 20–50). REFRAME Books.

Mori, M. (2012, June). The uncanny valley (K. F. MacDorman & N. Kageki, Trans.). *IEEE Robotics & Automation Magazine*, 98–100. Retrieved from https://ieeexplore.ieee.org/document/6213238

Netflix (2019a). *How "The Irishman"'s groundbreaking VFX took anti-aging to the next level*. Retrieved from https://www.youtube.com/watch?v=OF-lEIIlZM0

Netflix (2019b). *The Irishman in conversation*. Retrieved from https://www.netflix.com/title/81212801

North, D. (2008). *Performing illusions: Cinema, special effects and the virtual actor*. Wallflower Press.

Prince, S. (2012). *Digital visual effects in cinema: The seduction of reality*. Rutgers University Press.

Prince, S. (1996). True lies: Perceptual realism, digital images, and film theory. *Film Quarterly*, *49*(3), 27–37.

Rose, S. (2019, June 10). Will Hollywood's new youthifying tech keep old actors in work for ever? *The Guardian*. Retrieved from https://www.theguardian.com/film/2019/jun/10/will-hollywoods-new-youthifying-tech-keep-old-actors-in-work-for-ever

Stadler, J. (2019). Synthetic beings and synthespian ethics: Embodiment technologies in science/fiction. *Projections*, *13*(2), 123–141.

Trenholm, R. (2017, October 20). How *Blade Runner 2049* made Sean Young young again. *CNET CBS Interactive*. Retrieved from https://www.cnet.com/news/blade-runner-2049-sean-young-rachael-mpc-visual-effects/

AUTHOR BIOGRAPHY

Kathleen Loock (Kathleen.Loock@engsem.uni-hannover.de), born 1981, is professor of American Studies and Media Studies at Leibniz University Hannover (Germany). She is PI of the research group "Hollywood Memories: Cinematic Remaking and the Construction of Global Movie Generations," funded by the German Research Foundation (DFG).