

Dream-sharing and human self-domestication

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Summary. There are many theories of the function of dreams, such as memory consolidation, emotion processing, threat simulation and social simulation. In general, such theories hold that the function of dreams occurs within sleep, occurs for unrecalled dreams as well as for dreams that are recalled on awakening, and that conscious recall of dreams is not necessary for their function to occur. In contrast, we propose that dreams have an effect of enhancing empathy and group bonding when dreams are shared and discussed with others. We propose also that this effect would have occurred in human history and pre-history and, as it would have enhanced the cohesiveness and mutual understanding of group members, the fictional and engaging characteristics of dream content would have been selected for during human social evolution, interacting with cultural practices of dream-sharing. Such dream-sharing may have taken advantage of the long REM periods that occur for biological reasons near the end of the night. Complex narrative dream-production and dream-sharing may have developed alongside story-telling, utilising common neural mechanisms. Dream-sharing hence would have contributed to Human Self-Domestication, held by many researchers to be the primary driver of the evolution of human prosociality, tolerance and reduced intragroup emotional reactivity. We note that within-sleep theories of dream function rely on associational rather than experimental findings, and have as yet untested and speculative mechanisms, whereas post-sleep effects of dream-sharing are readily testable and have mechanisms congruent with the social processes proposed by the theory of Human Self-Domestication.

Keywords: Dreaming, dream-sharing, human self-domestication, empathy, mentalising, human evolution, social evolution

There are many theories of the function of dreams, such as memory consolidation (Wamsley & Stickgold, 2011), emotion processing (Scarpelli et al., 2019; Vallat et al., 2017), threat simulation (Revonsuo, 2000) and social simulation (Revonsuo et al., 2016; Tuominen et al., 2022). Although differing in what they propose as the adaptive role for dreams, these theories all hold that the proposed function occurs for unremembered dreams as well as for remembered dreams. This requirement is held because the majority of dreams will occur during a continuing sleep period, whereas it is only a minority of dreams that are followed by awakening and thence recall of the dream. These theories are all also evolutionary theories, in that characteristics of dreams highlighted by each theory would give an adaptive advantage and would thus be selected for across generations.

In contrast to these theories of within-sleep functions of dreaming, Blagrove et al. (2019b, 2021) have proposed that dreams have an adaptive function at the point of being told to others, in that they enhance empathy between the dream-sharer and those with whom the dream is told and

discussed. This proposal suggests that across human evolution there has been selection for fictional and story-like aspects of dream content that support this function, and also selection for the highly social and emotional characteristics of dream content. Details of such social characteristics of dreams are provided by Domhoff (1996) and Revonsuo et al. (2016), and include findings that in less than 5% of dreams the dream character is alone, that characters in dreams are more likely to be known to the dreamer in waking life than unknown, that the majority of behaviours of characters in dreams are what would be expected in waking life, and that dream characters are spatially and temporally quite stable and continuous within the dream, although transformations and discontinuities sometimes do happen. Furthermore, social interaction and acting with others occur often in dreams.

These dream content findings led Revonsuo et al. (2016) to formulate their Social Simulation Theory (SST) of dreams, which they considered in terms of evolutionary theories of Inclusive Fitness and Kin Selection, Reciprocal Altruism, and the Social Brain Hypothesis, which proposes that the costs and benefits of social interactions have been a critical driver for cognitive evolution. They also relate these evolutionary theories to social psychology findings of the Need to Belong, and of interpersonal attachment, putting forward a 'Strengthening Hypothesis', which states that '*the function of social simulations in dreams is to maintain and strengthen the dreamer's most important social bonds from waking life.*' [Emphasis in original.] The SST thus falls within the many proposals that there is some neural processing occurring during sleep to which dreams contribute, with, for this theory, prosocial behaviour being rehearsed in the virtual real-

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Submitted for publication: September 2021

Accepted for publication: February 2022

DOI: 10.11588/ijodr.2022.1.83442

ity of the dream, these neural changes during sleep then leading to prosocial behaviour change when awake. Key to this social simulation is that dreams exhibit a sociality bias, meaning that there is more social content in dreams than in waking life (Tuominen et al., 2022).

Critique of proposed within-sleep functions of dreams

A first issue with all theories of a within-sleep function of dreams is that there is little evidence that dreams are more permanent than short-term or even sensory memories. Unrecalled dreams might thus have no effects longer than the duration of the dream itself. Recall of dreams on awakening in the morning is fragile, as the dream needs to be retrieved during the life of the short-term memory trace if it is to be recalled later (Koulack & Goodenough, 1976; Montangero, Ivanyi & de Saint-Hilaire, 2003; Ruby et al., 2021). Thus, lasting effects of the dream might only occur if the dreamer wakes and rehearses the short-term or sensory memory of the dream so that it transfers to long-term memory. There are reports of people remembering dreams later in the day, having seen some accidental cue, but arguably this does not count against a general sensory and short-term memory view of dreams, given that it is very rare for people to recall a dream from previous days or weeks in this manner.

A second issue is that claims to tie the general characteristics of dreaming to possible functions of sleep, and in particular REM sleep, such as Perogamvros et al. (2013), Perogamvros and Schwartz (2012), and Stickgold et al. (2001), or to tie dreams to virtual reality simulation (Valli et al., 2005), are speculative and still leave room for dreams to be epiphenomena. Other examples are linking dreams to the default mode network (e.g., Domhoff & Fox, 2015; Fox et al., 2013), and also to neural replay during sleep (Wamsley & Stickgold, 2011). In neural replay sequences of neurons that are activated in waking life then replay during sleep, as has been found for rats after following a path or maze when awake (Gillespie et al., 2021; Louie & Wilson, 2001). However, neural replay has not been shown empirically to be related to dream content, and neural replay is mostly found in NREM sleep and wake rather than REM sleep (Findlay, Tononi, & Cirelli, 2020). Persuasive therefore is Wamsley's (2014) conclusion that: 'The brain mechanisms of dreaming are likely not identical to those responsible for memory consolidation. Although the content of dreams is influenced by memory consolidation, it may be that not every element of every dream is related to this process. If conscious experience during sleep is the emergent result of neural activity distributed across much of the brain, only a portion of this activity would be expected to be influenced by the activity of memory systems.' And that 'Dreaming reflects the functional brain process of memory consolidation, but this does not mean that dreams, per se, have a function.' Dreams might thus take their initial content from memories being processed during sleep, but then process those memories for other purposes, or for no purpose, or for no purpose within sleep. This epiphenomenal view of dreams is explored in Blagrove (1992, 2011) and Flanagan (2000). (Intriguingly, there is a very recent functional view of dreams from Zadra and Stickgold (2021) who propose that the subjective experience of emotions in dreams is necessary for the dream function of within-sleep evaluation of novel associations that are created in dreams. This is indeed

an interesting possibility, but cannot currently be confirmed empirically nor distinguished empirically from the proposal that the dreamt emotional narrative is functional only when recalled and told after waking.)

The third issue for proposed within-sleep functions of dreams is that there is, as yet, no experimental (as opposed to associational) evidence that unrecalled dream content causes a change in waking life behaviour. For example, in Wamsley et al. (2010) and Wamsley and Stickgold (2019), improvement in learning task performance across sleep is associated with dreaming of the learning task, but these are associational findings, and importantly dreaming of the task in both studies was also found to be related to poor performance at pre-sleep baseline. Task-related dream content in these studies may thus be residues of recent waking life events and concerns, such as a concern of having shown poor performance on a task set by the experimenters, rather than having a role in within-sleep functional brain processes. These studies, and, for example, Cartwright's (1991) study on dreaming and response to divorce, can be classed as associational as there was no random allocation to dream content groups. We accept that experimental studies have shown psychomotor performance benefits of mental simulation when awake and during lucid dreams (Stumbrys et al., 2016), however, in these cases, there is awareness of the simulation occurring, and an intention to undertake the mental simulation, which would not be true for dreams in general.

Given the above issues, Blagrove et al. (2019b, 2021) proposed that functional and evolutionarily adaptive consequences of dream content could instead occur after sleep, as a result of the sharing of dreams, such sharing taking advantage of the long REM periods that occur for biological reasons near the end of the night. Phylogenetically, dreaming might have originated from memory consolidation or threat rehearsal or other functions, in early humans and other animals, or indeed might be no more than a spandrel, an epiphenomenon of sleep (Flanagan, 2000): the theory proposed here is that when dream-sharing started, new selective pressures began for the dream content. As described by Barrett (2007), if spandrels become useful they can then become subject to evolutionary selection. Dream content that supports empathy and bonding when the dream is shared may thus have been selected for during early human evolution, after complex speech had developed.

The proposal for a post-sleep empathic and group bonding function to dreaming has the advantage that measurement of hypothesised behaviour changes, such as interactions and feelings of intimacy with a partner (Selterman et al., 2014), is easily undertaken. Blagrove et al. (2019b, 2021) assessed one type of behaviour, self-rated empathy towards the other member of the dream-sharer/dream-discusser pair, finding a significant increase in empathy of the person discussing the dream towards the dream-sharer, with a medium effect size. This current paper addresses a possible wider theoretical context for this proposal of adaptive effects of dreams and dream-sharing, which places dream-sharing as part of human self-domestication (HSD), which is a major theory of human social evolution, and specifically as part of the more recent language-based mechanisms for HSD.

The human self-domestication hypothesis of hu-

man social evolution

The human self-domestication (HSD) hypothesis proposes that in human evolution there has been selection for reduced emotional reactivity, and, in particular, reduced intra-group aggression (Hare, 2017). This selection has resulted in humans exhibiting prosociality, self-control, tolerance, co-operation, and the ability to mentalise, that is, to recognise what others perceive, feel, intend and know. Wrangham (2019) provides a history of the idea of humans being self-domesticated: He writes that the term domestication had been applied to humans by the ancient Greeks and so predates theories of evolution, and that although Darwin considered the possibility of humans being domesticated, he rejected this as it was not clear how the selection would have occurred. Wrangham (2019) reviews the work of Dmitri Belyaev in the Soviet Union in the 1950s on the domestication of foxes, which was based on selection for docility, and which followed the model that domestication of dogs resulted from wolves that were less aggressive starting to coexist with humans. Belyaev found that after three generations of selective breeding some foxes would no longer show aggression or fearful responses to humans, and that, by the thirtieth to thirty-fifth generation of breeding, 70 to 80% of foxes were domesticated, which included approaching the experimenters to sniff and lick them. The foxes would also wag their tails and follow human gestures. In this domestication of foxes, a less reactive temperament may have replaced the natural fear of humans, resulting in an attraction to humans. Similarly, there were wolves with a temperament that allowed them to approach human settlements, and these then showed higher reproductive success. Wrangham also addresses that such selection by humans for reduced emotional reactivity changes not only temperament but also results in unrelated phenotypic traits, such as floppy ears and altered face shape, and, for dogs, social skills.

Wrangham (2019) states that a similar selection against reactive aggression has occurred for humans across the last 300,000 years, and that this also caused a reduction in face size, which is a characteristic of domesticated species. He states that, with language starting to develop from 100,000 to 60,000 years ago, individuals were then able to form coalitions so as to counter the most aggressive members. Wrangham (2019) reviews Hare's (2017) work on how reduced reactive aggression decreases fear responses to other humans, which gives more time for individuals to read other human's signals, including gaze direction, as shown by attention to the white of the eye (sclera), leading to increased co-operation. Wrangham concludes that the differences between *Homo sapiens* and Neanderthals 'may have been due more to emotion than to intellect' (p.197), and that our prosociality is underpinned by embarrassment and guilt, and the pain, and danger, of being ostracised. So as to illustrate prosociality, he contrasts bonobos with chimpanzees, the former being nonaggressive, trusting and very playful towards each other, and very accepting and welcoming of stranger bonobos joining the group. Bonobos have far lower aggression than other apes and no tendency to kill members of the same species. According to Hare (2017), bonobos evolved to be less aggressive because females were able to express a mating preference for less aggressive males, this was thus that species' mechanism for self-domestication. For Hare, human levels of co-operative communication were a result of an increase in social tolerance generated by a decrease in emotional reactivity. According to this hypoth-

esis, an increase in tolerance in humans allowed inherited cognitive skills to be expressed in new social situations. For example, Hare notes that infants with the least aggressive and most socially reserved temperaments show the earliest expression of the false belief understanding that supports co-operative forms of communication.

The HSD predicts that increases in self-control and reductions in reactivity, as a result of an increase in brain size, steadily drove the evolution of tolerance and social cognitive skills, including empathy and mentalising (which both attribute mental states to others), mediated by white sclera, prefrontal mechanisms and oxytocin. Hare (2017) details how the widening of developmental windows as a common consequence of domestication, with the extended juvenile period, facilitates participation in cultural forms of learning. He also describes how the brain's cortical social network (i.e., the temporal parietal junction, superior temporal sulcus, and medial prefrontal cortex) became increasingly active in infants during this period of globular brain development, leading to a more rounded skull. As a result, for humans, synaptic pruning in regions of the prefrontal cortex related to self-control is delayed and is only complete in our mid-twenties. Synaptic pruning occurs at different times for different areas of the brain in humans, which widens the developmental window, supporting social cognition and prosociality. Hare (2017) concludes that, combined with cooking and thus nutrient dense food, there is then an evolutionary feedback loop that increases brain size, and resulted in an explosion of cultural artifacts beginning around 80,000 years ago.

Cultural and language extensions of HSD

The above stance on HSD is highly biological, including, for Wrangham, the use of legal and extra-legal executions so as to rid the group of over-aggressive and anti-social individuals, and of their genes. A more psychological and cultural extension of HSD is explored at length by Shilton et al. (2020), who ask whether the above evidence could better be described as selection for co-operation and emotional control, as is observed in many other highly social mammals, rather than as self-domestication. They propose a first stage of human social evolution involving mimetic communication, with mimetic speech developing half a million years ago, and the beginnings of musical engagement. Engagement with music is proposed to bond the group together through emotional and embodied unity. The second stage involves an increased sophistication of language, when individuals begin to 'instruct the imagination of their interlocutors' (see also Dor, 2015), which relies even more extensively on emotional plasticity and culturally learned emotional control.

Shilton et al. (2020) propose that engagement in music and in linguistic communication contributed significantly to the evolution of cognitive and emotional plasticity in the genus *Homo*. They interpret the recent evolution of humans, especially after the split with Neanderthals, as the outcome of intense cultural evolution driven by language, musicking and other cultural strategies, rather than by selection against aggression. They note that whereas domestication usually reduces brain size, selection for emotional control could account for the continued increase rather than decrease in brain size for most of human evolution. Because of the selection for broader social plasticity and nuanced so-

cial emotions, including the development of blushing, they caution about the analogy with domestication, which they say ‘focuses too much on the reduction of reactive aggression and too little on social organization.’

Shilton et al. (2020) detail how language goes beyond the immediate communication event, and allows the communication of experiences, norms, skills and worldviews beyond what was possible through mimesis. With language, individuals begin to take into account things they themselves have never experienced, things they have only heard about, as well as sharing conceptual thinking, complaining and making complex plans. Shilton et al. emphasise the importance here of communication by stories, whether factual or fictional, the role of which in co-operation is also detailed by Smith et al. (2017).

For Shilton et al. (2020), the social evolution of humans is better explained in terms of selection for prosocial motivation and self-control, which are guided by symbolic communication and representation, rather than as a process of self-domestication, and that ‘the brains and minds of the communicators became adapted to the culturally evolving communication systems, thereby generating, through positive feedbacks, an ever-widening co-evolutionary spiral.’ The current paper proposes that the culturally evolved communication system could have involved the sharing of dreams upon waking, allied to the evolution of story-telling, but retains viewing this in terms of HSD, given the prominence of that theory within human evolutionary science (Hare & Woods, 2020; Price, 2019) and given its highlighting of empathy, mentalising and reduced emotional reactivity.

Story-telling, fiction, dreaming and human evolution

Narrative can be mimetic, but when detached from immediate surroundings as stories, gives us access to the experience of others, to learning from others, to the distant past, and to imagining various futures. There are individual and social benefits to engaging with stories. According to Boyd (2018), early in human evolution narratives would be limited to what had already happened or was happening, but when this became combined with play, fiction arose. For Boyd, there would be a craving for understanding our world not only in terms of our own direct experience, but through the experience of others, whether those others were real or, as occurs in fiction, imagined. Such stories may have emerged mostly around the campfires our ancestors have regularly used for around 400,000 years (Dunbar, 2014). Boyd (2018) details the personal, social and cultural benefits of fictional and non-fictional narratives and of their sharing, including understanding causality and the perspectives of others. Fiction would have arisen as one characteristic of play, and would be a learning, bonding, and corrective mechanism. Language, narrative, play and sociality would all then synergize each other.

To summarise, humans have evolved to have reduced emotionality and increased prosociality and empathy, with this selection described as Human Self-Domestication (Wrangham, Hare) or as prosocial motivation and self-control (Shilton). These processes may be aided by mimetic and, more recently, fictional narratives (Boyd, Dunbar). However, fictional narratives are not only produced during wakefulness, but also during sleep, as dreams. We will now introduce dreaming into this line of argument about social

evolution, with a quotation from Boyd (2018, p.9):

‘And every night, too, the actor-scene network was already active. Dreaming appears to occur in many species. It too combines memories into new configurations. We experience dreams as immediately present to the inner eye and as engaging both attention and emotion. To that extent dreams resemble and probably anticipated fictional narrative, and would have had more raw material to play with the more frequently and more elaborately factual narrative had begun to circulate. But dreams recombine elements of memory in apparently stochastic and therefore arbitrary and usually poorly retrieved ways, even if they can be triggered by current preoccupations or moods. They mostly provide meager direct hints either for waking life or for fiction. I suggest that the main function of dreams may be to keep the retrieval and recombinatorial mechanisms of the default or actor-scene network in good running order for daytime retrieval and planning—with the consequence that the network was also already available for idle daydreaming and could easily be coopted for purposeful fictional invention.’

Boyd’s inclusion of dreaming into human social evolution is intriguing, but his characterisation of dreams as providing ‘meager direct hints either for waking life or for fiction’ suggests a cognitive deficiency view of dream cognition that much work in the field has countered. For example, Sándor et al. (2015, 2016) find high levels of complexity in even children’s dreams in terms of self-representation and interactions of characters, Domhoff (1996) shows extensive continuities between wake life conceptualisations and dream content, and Edwards et al. (2015) and Blagrove et al. (2019a) show personal insight gains from group consideration of dreams. Regarding narrative complexity, Pace-Schott’s (2013) paper *Dreaming as Story-telling* reviews how the default network (Andrews-Hanna, 2012) produces a ‘hard-wired’ tendency to represent reality in the form of narrative (see also Fox et al., 2013), and he shows similarities between the brain basis of story production and dream production, albeit with some differences, such as reduced reflexivity and self-awareness during dreaming. There may indeed be common processes between dreaming and storytelling, in that both are narrative representations (or simulations) of waking life. Cipolli and Poli (1992) show by use of story grammar measures that story-like organisation seems to be a feature of dream production rather than just reconstruction at the point of recall, there is also thematic progression and increased complexity across REM periods in the first half of the night. Cipolli et al. (1998) also find through story grammar measures a greater complexity of reports collected in the second half of the night compared to the first half. Similarly, using a story grammar tool to parse dream reports into their constituent components (actions, scenes, characters), and to identify the causal precursors and consequences of actions, Nielsen et al. (2001) found that, for high frequency dream recallers, REM dreams were more likely than NREM stage 2 dreams to contain episodic progression.

However, although methods for analysing stories can be applied to dreams, Montangero (2012) cautions that the narrative organisation of dreams should be best compared to that of informal waking reports rather than canonical stories, as dreams are often incomplete and closer to short stories or to a succession of fragments of stories. This ties in with States’ (1993) chapter *Meaning in Dreams and Fiction*, where he concludes that dream narratives instantiate preconceptual or felt or implicit meanings from waking life, without an

intentional plot. Nevertheless, these dream narratives, even if not canonical stories, may be sufficiently evocative when told to affect the listeners and to effect mutual understanding and bonding. From the papers just reviewed this may be more likely for REM dreams from late in the night, which are also the ones that are more likely to be shared, as they occur at morning awakening.

We suggest that the timescale for dreams becoming functional in humans, through sharing, is the same timescale for storytelling having emerged, which is estimated by Pagel (2017) as occurring from 40,000 years BCE, with cave art depicting series of events, and the creation of other art and cultural artefacts, in parallel with the development of complex grammatical language. Although the use of dreams in human pre-history cannot be shown or studied, there is considerable evidence for their use currently and recently in hunter-gatherer societies (e.g., Gregor, 1981; Pandya, 2004; Peluso, 2004; Wax, 2004), and so dreams in pre-history may have been treated as worthy narratives in themselves, and may also have provided some of the first fiction that humans could tell. Many of these hunter-gatherer dreams are socially important, and some may be passed down in folklore, and have been termed 'big dreams' (Bulkeley, 2016), which may even have a part to play in religion. But with their valuing comes the possibility that the telling of ordinary dreams may have occurred, and bonding and self-revelation could have resulted from this, given that the method of interpretation of dreams by relating them to waking life is evidenced by historical materials from ancient cultures (Hughes, 2000).

Blagrove et al. (2019b, 2021) show that the discussion of ordinary dreams leads to increases in empathy from the discussor towards the dream-sharer, which they explain as due to the exploration of the fictional dream narrative, leading to self-disclosure by the dreamer of their waking life circumstances as a result of the discussion mapping the dream onto the dreamer's recent waking life. The mechanism proposed in these papers for the empathic effects is that the dream is fictional, as dreams only very rarely provide replays of waking life events (Fosse et al., 2003), and that it is the exploration of fiction that results in appreciating the life circumstances and emotions of the dream-sharer. There have been robust and extensive findings of the relationship of empathy to engagement with literary fiction, as reviewed in Oatley (2011, 2016). More recently, Rathje et al. (2021) found that attending live theatre improves empathy, changes attitudes, and leads to prosocial behaviour. After seeing plays, compared to before, people reported greater empathy for groups depicted in the shows, held opinions that were more consistent with socio-political issues highlighted in the shows, and donated more money to charities related to the shows. Although these experiments are performed in a modern context, in individualised societies that value self-disclosure, it is plausible that early humans, in waking up from a dream and telling it, might attempt to relate its components to waking life events, and hence the private life and knowledge and emotions of the dreamer might be externalised. The usefulness of mentalising and empathy to the group and to individuals would lead to selection for the brain mechanisms that support the production of dreams that have considerable social content, and the ability to create and tell dreams may also have been subject to sexual selection, akin to selection for other creative abilities, such as artistic virtuosity (Miller, 2001).

HSD and within-sleep and post-sleep functions of dreaming

The HSD theory emphasises the importance of play, and of domesticated species having extensive periods of the lifespan in which play can occur. As reviewed above, one of the facets of play is the production of fiction. Play has also been related to dreaming by Bulkeley (2019), who states that 'dreaming is imaginative play in sleep, play being incompletely functional, spontaneous, initiated in the absence of stress, often part of an animal's juvenile period.' He then discusses how the default network, continuing to run during sleep (Fox et al., 2013; Horowitz et al., 2009; Raichle & Snyder, 2007), may be a possible brain basis of this imaginative play. The sharing of the night-time fictions produced by this imaginative play would be expected to show many of the interpersonal and social benefits proposed by the HSD theory.

Interestingly, however, Bulkeley (2019) also raises the issue of unremembered dreams. He asks 'if only *remembered* dreams serve a function, does that mean the function resides in the waking use of the dreams, rather in the dreams themselves?', to which he answers: 'One of the key advantages of the dreaming-is-play proposal is that the valuable functions of dreams do *not* depend on their conscious recollection' and that 'the experience of imaginative play during sleep, that is, dreaming, seems to be driven by similar impulses toward healthy growth and flexible preparation for waking life challenges, and these impulses can be satisfied by the dream-playing itself, regardless of conscious recall afterward. Remembering the dreams may help, but it is not necessary.' [Emphases in original.]

Following the reasoning in the early part of this review, a response to this statement by Bulkeley (2019) is to suggest that the function of dreams resides in their waking use, and that remembering them is essential to this function. To examine further this distinction between within-sleep and post-sleep functions of dreams, we consider here firstly the emotion regulation theory of dreaming, which holds that emotions are processed during our dreams (Cartwright, 2010). Examples of evidence for this proposed processing are that emotions are lower in our dreams than when experienced in waking life (Vallat et al., 2017), and that the emotions in dreams change across the night. But what if the emotion processing occurs not during sleep, but when awake, as a result of telling and considering the dream? Such processing of emotions with others, as a result of the group or social consideration of the dream, is part of the hypothesised role of dream-sharing within HSD, as to explore dreams as a group activity enhances levels of mentalising and mutual emotional understanding. To illustrate how data that may support claims for within-sleep effects or even functions for dreams can also be interpreted in favour of a post-sleep dream sharing effect or function, we address here firstly the interesting findings of Bergman et al. (2020). These authors report a content analysis of 632 dreams of 150 Polish Auschwitz survivors, collected in the 1970s, and comprising retrospectively recalled dreams from before World War II, during imprisonment, and after the war. War-related and threat dreams were found to be more common after the war than during imprisonment, and dreams involving family and freedom-related themes were found to be more common during imprisonment than they were before or after the war.

Bergman et al. (2020) discuss which theories of dream function and of post-trauma nightmares can account for this pattern of results, and give reasons why the data do not accord with some theories. The authors focus on the emotional processing that a dream may be performing for the individual, and the relationship of dream content to waking life experiences occurring at the time of the dream. In contrast, the empathy theory of dreaming, and the proposal for the inclusion of dream-sharing within HSD, would lead to consideration of the effects of sharing these dreams. Although dream sharing was not addressed in the Bergman et al. (2020) paper, we can use their dream content data to suggest possible effects of sharing dreams with such content. In this regard, sharing during imprisonment a dream of one's prior life, worth and identity would aid the encouragement of social bonding and empathy during the terrible circumstances of the concentration camp. However, after the war, sharing dreams of the concentration camp encourages social bonding and empathy towards the dreamer for what they have experienced, this sharing sometimes occurring in the face of social, political, and cultural downplaying, ignoring or even denial of those experiences. The sharing of dreams with these contents would thus be adaptive and of benefit to the group, in that self-disclosure and group bonding is promoted, even if from the standpoint of the individual the post-war dreams bring back painful memories.

To further illustrate this distinction between within-sleep and post-sleep functions of dreams, we consider secondly the NEXTUP theory of dreaming (Zadra & Stickgold, 2021), which holds that in REM dreams 'weakly associated networks are being explored to understand possibilities' (p.111), and that the brain combines memories 'into a dream narrative that explores associations the brain would never normally consider.' (p.109.) Zadra and Stickgold illustrate the theory with a dream that Stickgold had in his first faculty position when helping to lead a lab class in which anaesthetised dogs would be operated on by medical students, a class that he says he was 'too squeamish' for. He reports a dream in which as a dog's chest was being cut open, he 'suddenly realized that it wasn't a dog; it was my five-year-old daughter, Jessie.' (p.113.) On waking, Bob told the dream to his wife and discussed it with her. Zadra and Stickgold conclude that 'This association, Jessie and the dog lab, was a valuable one. Something was uncovered about the fragility or sacredness of life that was important, something worth marking and strengthening and keeping available for the future. Once these connections were strengthened, the brain's job was done. Whether Bob remembered the dream when he woke up or not didn't really matter.' (p.113.) In our view, the dream's novel association between a vulnerable dog and Bob's daughter may well have been produced during sleep. However, the strengthened connection that results might be initially between dream-sharer and listener, when the dream is told and discussed, rather than between neurons during sleep, although, obviously, the dream recall and discussion also make permanent the newfound link the dream created between vulnerable dog and daughter.

Costs and benefits of dream-sharing

Any theory of benefits of dream-sharing needs to take account of balancing possible costs and benefits of dream-sharing. Regarding benefits, it is not necessary to hypothe-

size that dream-sharing contributes more to group cohesion than does fiction sharing, as they may have similar levels of effect. Instead, the claim is that dreams are an additional source of instances of fiction, they increase the amount of fiction that is shared, but with some characteristics that make them different from fiction that is produced in waking life, such as being created spontaneously and without intention or plan. And people are motivated to share dreams. In Graf et al. (2021) the highest ranked motives for participants' most recent instance of sharing a dream were, with highest first, "Because I was interested what the other person would think about the dream", "To emotionally relieve me", and "Because I wanted to better understand the dream". Lower scores were given for "For entertaining reasons", and "Because the other person occurred within the dream"; here we would note that even telling a dream for entertainment or humour can be bonding. The lowest score was given for "To make myself more interesting for others". A benefit of dream-sharing is thus that it fulfils these motivations.

There are, however, costs in that some dreams might be confusing or simply bizarre and with no recognisable benefit to dreamer or listener. Some dreams might also be embarrassing to the dreamer or disclose personal information that disadvantages the dreamer. Recall also has to be balanced with the need for forgetting of the dream experiences, so that they are not mixed with waking life real events, as with the source memory deficits for dreams in narcoleptic patients which result in the detrimental mixing of real with dreamt memories (Wamsley et al., 2014).

The cost benefit analysis is further complicated by the occurrence of nightmares and troubling dreams that might be difficult to forget and which might be adverse to mental health or happiness in waking life. Nevertheless, there may often be benefits to sharing negatively toned dreams, just as there are benefits to the revelation and expression of one's negative thoughts and memories (Ruini & Mortara, 2022). Sliwinski (2017) gives examples of the nightmares of people in very distressing political circumstances: Nelson Mandela dreaming in prison of being released and of finding his home empty, with no-one there, and the nightmares of people subject to colonial violence in Algeria. For certain nightmares Sliwinski accepts that what she calls the dream-work function can be damaged under conditions of severe stress, and a similar point is made by Kramer (1991) and Levin and Nielsen (2007). Sliwinski, Kramer, and Levin and Nielsen are referring to the failure of putative within-sleep functions of dreaming; in contrast we would suggest that extremely adverse waking life circumstances and nightmares will be highly distressing to the individual, but that seen in the light of HSD the nightmare, and even a PTSD nightmare, is still expressive of those waking-life circumstances that caused the nightmare, and hence the post-sleep expressive function of the dream would be maintained, even though proposed within-sleep functions would be expected to be disrupted. Importantly, the content of dreams does not itself have to be domesticated, in the sense of emotionally unreactive and affiliative, to have a domesticating effect when shared. Dreams may have aggression and other anti-social activities, but the same is true for films, be they horror, drama or thrillers. It may be that the sharing of such negativity and drama aids to bring people together through experiencing troubling narratives together, much as the experience of Halloween for children can do.

Future research

Although the majority of the human population may be characterized by human self-domestication there may also be alternative evolutionary strategies for a small proportion of the population, and that proportion might not have had the same dream content or dream-sharing characteristics as is hypothesised here for the majority of the population. For example, Lyons et al. (2019) found that the frequency of aggressive dreams is predicted by the traits Machiavellianism and psychopathy. Future research on the characteristics of dreams that result in post-sleep prosocial effects should take account of such individual difference factors.

Future research should also address empathy for positive experiences. In a field study, Depow et al. (2021) found that empathy for positive experiences is as common as for negative experiences, and that empathy more often occurs for those to whom we are close than to strangers. They conclude that laboratory studies have led to a priority for empathising empathy for the negative situations of strangers. Depow et al.'s finding is very relevant to the proposal for dream-sharing being important for empathy and for HSD, as dreams are as likely to be emotionally positive as negative (Schredl & Doll, 1998), and sharing of them usually occurs between people who have a close relationship (Graf, Schredl, & Göritz, 2021). Finally, it is also important to address tentative sharing, where the sharer is unsure of whether to tell a dream due to what it unwittingly reveals (Rycroft, 1981), or, alternatively, where the sharer is using the dream as a way to broach a subject with the listener.

Conclusions

We propose that dreaming may have a function after sleep, when the dream is shared, in contrast to many current theories which propose effects of dreaming during sleep. We propose that the mentalising, emotion processing, empathic and bonding effects of such dream-sharing would be of such advantage to groups of humans that it may have played a role in the social evolutionary processes described in the theory of Human Self-Domestication. Despite the possibility that our proposal reads back current uses of dreams to human pre-history, we suggest that research into possible functions of dreams should take into account that such functions may occur after sleep, when dreams are recalled and shared, and that the empathic, emotional and bonding effects of such sharing should be seen in the context of the evolutionary theory of Human Self-Domestication.

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