Connected Creativity: The Impact of Web Search on Everyday Creative Thinking

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Abstract

With more than 60% of the world's population online, how does our rapidly evolving digital world impact creative processes and outcomes? On the one hand, there is the promise of the shared knowledge and ideas of humanity, readily available at our fingertips, providing numerous starting points from which to develop new ideas. On the other hand, we may be overwhelmed by the volume of information, struggle to find and identify quality information to form the basis of a creative thinking process and instead fall back on common, accepted, ideas. Throughout this article, we place creators and creating in the ubiquitous situated context of searching the web and consider the implications for a range of everyday creative thinking processes. Research in this area is surprisingly limited, and a number of suggestions are made to take this area forward as the web becomes an ever-expanding part of our cognitive ecology.

Keywords: Creativity, creative thinking, ideation, divergent thinking, internet, web, information search.

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Web search gives us access to information and ideas from around the globe, so can we take advantage of this 'digital expansion of the mind' to make ourselves more creative? Around 60% of the world's population is now online, spending on average over 6 hours a day connected (Salim, 2019). The web allows us to traverse a seemingly endless information space that continuously expands and evolves (Heersmink, 2016; Marsh & Rajaram, 2019); a multifunctional environment in which all manner of processes can occur. It is constantly available, searchable and for most of us part of our 'cognitive ecology' as we interact with our environment (Smart et al., 2017) to such an extent that web searching has become an almost invisible part of everyday life (Sundin et al., 2017).

Of course, seeking information to support creative activity and facilitate ideation is not new. Creators of all kinds look for domain knowledge to provide procedural information, motivate, inspire, generate and evaluate ideas, and they search for finished examples of other creators' work (for example, Palani et al., 2021; Zhang & Capra, 2019; Zhang et al., 2020). The connected digital world provides a new medium to find information, access multiple opportunities for creative experiences and to engage with other creators across multiple domains including everyday creative behaviour (for example, Cook et al., 2020; Literat, 2018; Literat & Glaveanu, 2016;). There remains, however, a persistent question about the impact of the internet and our connected digital world on our cognitive functioning (for example Barr et al, 2015; Carr, 2010; Ellis, 2019; Firth et al., 2019; Marsh & Rajaram, 2019).

How then, might the digital world impact on creative cognition? This seems likely to vary according to the nature of the domains and the materials in which creativity is expressed, differences in the levels of skills and expertise of creators, and differences in the context in which creativity takes place. Consequently, there are many paths that could be taken to start exploring the impact of the digital environment on creative cognition. In the present work we focus on arguably the most ubiquitous, and therefore widely applicable, digital extension for creativity; searching the web for information to support everyday creativity. Whilst there have been various attempts to design enhanced search tools in support of creativity (e.g. see Kules, 2005), here we confine ourselves to search using standard search engines (e.g. Google) that are commonly used. Can everyday creators use web search to help find and build on those ideas that are more creative, or will they be overwhelmed and fall back on common ideas, which may be less creative? And how might the process of creating be different in this situated digital context? In the present article, we argue that the impact of web search on everyday creative thinking processes is deserving of wider attention in the research literature. We make this point and elaborate on a series of potential areas for research by considering the possible impact of web search on a range of creative thinking processes.

Situating creative cognition in a web search context

The web is not a single homogenous thing but instead has a role that is very much defined by the user. Interaction with web search involves a reciprocal two-way flow of information that requires our cognitive input to the search bar, and in scanning and evaluating the resultant ranked search engine output (Heersmink & Sutton, 2020). The web

can provide access to knowledge that we do not otherwise have, offering alternative and diverse perspectives, ideas, experiences and understanding, creating something akin to an extended memory network for the user. However, understanding the bi-directional relationship between this digital context and our cognition does not lend itself to easy judgements and assumptions (Heersmink, 2016; Smart et al., 2017) due to the constantly evolving and multifunctional nature of the web, and our differing cognitive profiles and motivations for using the web, and other individual differences.

Fundamentally, creativity involves the production of ideas that are judged to be both novel and effective (Plucker et al., 2004; Runco & Jaeger, 2012). This creative process is underpinned by dual processes to generate and evaluate ideas (see Sowden et al., 2015 for a review). If there is general agreement that creativity is the generation of ideas or products that are novel and effective, there are many theories about "the sequence of thoughts and actions that leads to novel, adaptive productions" (Lubart, 2001, p. 295). Wallas (1926) described the creative process as consisting of preparation, incubation, illumination and verification. Traversing Wallas' stages, idea generation, exploration and evaluation have been identified consistently as foundations of the creative process from Guilford onwards (Guilford, 1950, 1956), with divergent thinking, convergent thinking, associative and analytic thinking necessary in a variety of orders and intensities (Sowden et al., 2015; Lubart, 2018). These cognitive and affective processes act on knowledge, information and affective input (Dietrich, 2004); re-combining and re-organising them to allow for the generation of new ideas that are evaluated and refined to create viable products and solutions (Lubart, 2001; Mumford et al., 2012). This dynamic blend of cognitive sub-processes describes a creative process which does not come about in linear, fixed stages, but in dynamic interactions

between sub-processes, sometimes operating concurrently (Beaty et al., 2016; Harms et al., 2018).

Given the complexity of creative processes, we might expect a wide range of possible impacts of using web search to support everyday creativity. To illustrate, we consider a selection of key components of the creative thinking process, and how they might be impacted when searching for ideas on the web; digital content creation and social media platforms are outside the scope of this paper.

Preparing for Creativity

In any creative process, finding a place to start – "the fuzzy front end" (Goncalves, 2016, p. 1), is a period of uncertainty. Identifying and framing the task at hand, and the search or solution space, is a difficult but necessary first step to knowing which direction to take and is a common starting point for many creative cognition theories (Sawyer, 2012; Goncalves et al., 2016). Avoiding the automatic or instinctive framing of a problem with a ready-made solution is key. Active engagement with problem construction or problem definition gives structure, a framework for the creative processes that follow (Mumford et al.,1991; Mumford et al., 1996). Active engagement with this initial process is more common in creative individuals, and has been consistently associated with increased creativity (Mumford et al., 2012; Reiter-Palmon, 2017).

Similarly, accessing the web is active – you have to look for what you want (Marsh & Rajaram, 2019) and filter out what you do not want. To conduct a successful search, one must first think (Storm, 2019), and continue to think. Generating a search query relevant to your needs is a complex process when your needs are ill-defined, and as such it requires

active cognitive engagement to define and construct a problem space for a search to produce a useful solution space. Semantic, lexical and conceptual domain knowledge aid effective searching (Dinet, et al., 2012), but search queries are usually short statements of search intent (White & Roth, 2013), and the searcher relies on the evaluation of search engine results to judge the effectiveness of their search query at meeting their information needs.

Search engine results are mediated by algorithms that filter and rank results in an attempt to offer the most relevant content, a process which is generally opaque to most web users. Thus, search engine selectivity can lead to homogeneity bias and popularity bias (Barker, 2018; Nikolov et al., 2019), known collectively as a 'filter bubble'. Homogeneity bias is further exaggerated by personalisation algorithms, which use knowledge of previous search behaviour and geographical location to contextualise search intention. This biases the selection of information to that which is already familiar, or at least 'adjacent unknown' information which appears to be new but not radical, and which may be geographically and culturally limited (Barker, 2018) – more relevant than novel.

Thus, the web, by and large, provides a solution space that is automatically constrained. Consequently, the serendipitous encountering of truly novel knowledge and information can be difficult to achieve using a traditional search engine (Taramigkou et al., 2017). Relevant domain knowledge and expertise can both help and hinder the search process, but finding the right search terms to use is difficult, with most people tending to rely on familiar search terms and websites, further limiting their exposure (either consciously or unconsciously) to new perspectives and information (White & Roth, 2013). As a result, the process of searching the web can create an 'Einstellung' effect; alternative knowledge and information that may lead to a better 'solution' is not offered unless you

search for it and clearly, one is not always aware of what one does not know. The web effectively fixates on what it infers from your search terms, confirming bias and limiting search space, selecting knowledge and information which is consistent with an existing narrative or 'mental set' (Bilalic et al., 2008; Wiley, 1998).

In addition, one's existing knowledge contributes to a 'feeling of findability'. This is an intuition based on how difficult it will be to create a search and the popularity of the information you are looking for (Liu et al., 2015; Risko et al., 2016). A low feeling of findability predicts the likelihood of unsuccessful search (Risko et al., 2016) and can be de-motivating. Conversely, familiarity with web searching can create the perception that searching is easy, resulting in a lack of effort in the search enterprise (Haider & Sundin, 2019; Rieh et al., 2012).

In sum, the processes of creative problem construction and search query construction appear to have much in common (Brand-Gruwel et al., 2009; Sharit et al., 2008), though each comes with its own complex set of limitations. To date, there is no comparative research examining this similarity and how the two processes overlap or interact. In a web environment, preliminary ideas and conjectures can be operationalised as search terms, providing an entry point to exploring a problem. The uniquely rapid feedback provided by a web search can quickly clarify the adequacy of the framing of a problem, allowing more progress to be made in a shorter time. Thus, a co-evolution of the problem space and the solution space may take place at an accelerated rate, with incremental and interdependent cycles of information offloading and intake, search and evaluation happening from the start of the process. For example, faced with the everyday task of finding a creative gift a searcher might think that something homemade would have an element of uniqueness and operationalise this using the initial search term 'homemade

gift'. Initial search results might include online shopping sites that sell homemade gifts, sites offering lists of homemade gift ideas, and some examples of specific homemade gifts. Seeing the example 'bath bombs' might spark the idea to search for the more specific gift idea of 'homemade soap', which is elaborated into 'homemade soap recipe' by a search engine suggestion. Although this process has rapidly refined the initial gift idea, it has been fundamentally limited by the initial searcher idea and the search engine filter bubble resulting in a solution that ultimately might not be judged especially creative, but perhaps just creative enough by the searcher. Nevertheless, research has found that learning increases during web search, which in turn influences subsequent search and evaluation behaviour, (Kammerer et al., 2018), although further research is needed to examine how the process unfolds in a creativity context.

Enquiring and ideating

Often seen as a sub-process to follow problem construction, enquiry and information search may actually operate in tandem with problem construction; the framing of a problem initiates a search for additional information that is evaluated and feeds back into the framing of the problem increasing the likelihood of generating a creative outcome (Ball & Christensen, 2019; Harms et al., 2018). This process bears similarity to the iterative process of web-searching we outlined in the previous section.

Perceiving and attending to information in one's environment and linking new information with existing relevant knowledge forms the bedrock of the enquiring process during creative thinking. Attentional control is needed to shift and inhibit attention, to focus and de-focus attention, and to evaluate the relevance of stimuli to the task at hand. The

ability to flexibly shift between different types of attention appears to be a characteristic common in creative individuals (Gabora & Kaufman, 2010; Kauer & Sowden, 2020; Vartanian, 2009; Zabelina & Robinson, 2010). The different types of attention associated with creativity – broad, focused, leaky, flexible, for example, may vary by degree and by individual (e.g. Carson et al., 2003; Zabelina, 2018; Zabelina & Robinson, 2010), and be necessary in different combinations and to differing degrees in different contexts and tasks.

Drawing on the enquiry process, generating creative ideas requires both divergent and convergent thinking – thinking processes which are generative and evaluative, sometimes spontaneous, and sometimes controlled, with dual-process models of cognition suggesting the possibility of a dynamic interaction and shifting between Type 1 and Type 2 thinking processes (Benedek & Jauk, 2018; Finke et al., 1992; Pringle & Sowden, 2017a, 2017b; Sowden et al., 2015). A shifting balance of associative and analytic modes of thinking is thought to underpin the generation of ideas, where one may be more active or equally as active as the other, or where they may be tightly meshed and operating in tandem (Nijstad et al., 2010; Pringle & Sowden, 2017a, 2017b).

Moreover, new ideas represent transformations, variations and re-combinations of knowledge (Benedek & Fink, 2019; Mumford et al., 1991; Reiter-Palmon et al., 1997). Thus, generating ideas which are creative, or potentially creative, is an information-intense process of integrating and synthesising information from external sources and linking it with existing knowledge, expertise, and the task at hand. Some recall relies on more salient knowledge and associations that are intuitive and easily recalled from semantic memory, and some may require more effortful, active and strategic executive control of attention to inhibit and suppress obvious ideas to find less obvious and more remote associations (Beaty & Kenett, 2020; Beaty & Silvia, 2012; Gilhooly et al., 2007; Mednick, 1962).

Exposure to other people's knowledge and ideas, often referred to as 'cognitive stimulation', can increase the originality of generated ideas (Fink et al, 2010; Fink et al, 2012; George et al., 2019; Glaveanu, 2020; Nijstad et al., 2002; Ritter, 2012). Even when more attention is given to seemingly irrelevant information, creative outcomes can be enhanced (Agnoli et al., 2015; Zmigrod et al., 2019). Further, divergent thinking and flexibility can be enhanced when encountering cues in the environment that are inconsistent with expectations (Goclowska et al., 2014; Ritter et al., 2012).

The web has the potential to enhance enquiry and creative idea generation processes through cognitive stimulation in several ways, and we highlight two particularly salient possibilities. First, the process of acquiring and synthesising knowledge from search processes provides potentially less obvious and more remotely associated knowledge than would otherwise be available to a single individual, some of which may be stimulating and inspirational. This provides greater raw material for transformation, variation, and re-combination through which creative ideas can emerge. Second, the searching process can also provide information about existing or half-baked ideas and solutions, ideas with potential originality, which can be honed in ways that incorporate new perspectives and contexts, leading to new creative ideas (Corazza, 2016; Gabora, 2017). Indeed, treating the search process as a creative process in itself can lead to the synthesis of creative ideas (DeSchryver, 2017).

But to what extent are the potential benefits of the web likely to be fulfilled in practice? Information foraging theory (Pirolli & Card, 1999; Pirolli, 2005) provides a useful predictive model of information search behaviour that seeks to understand how people behave when searching for information (Blackmon, 2012; Ong et al., 2017; Savolainen, 2018). The theory proposes that users 'forage' the web for information, maximising

information value whilst minimising the cost of finding it in resource terms (time and energy spent searching). Cues in the information environment, such as the results on a search engine output page, act as an information 'scent', which searchers follow to find relevant information (Ong et al., 2017). Searchers navigate through the information space to find high-yield patches of relevant information, exploiting information found, re-searching to find and explore new patches of information (Blackmon, 2012) or stopping the search. It is worth noting that a typical web search produces many thousands of results. Whilst in amongst these may be the fresh perspective or knowledge that stimulates someone's creativity, there is no guarantee that the information needed will be on the first results page. This makes searching difficult and time consuming (Storm, 2019), even when guided by information scent, requiring persistence if creativity-enhancing information is to be found.

Relatedly, although the availability of a wide range of information appears to enhance creativity, this can depend on the information processing and metacognitive skill of the creator (Reiter-Palmon et al., 1997). Whilst increasing the breadth of knowledge activation can positively impact creativity (Rietzschel et al., 2007; Nijstad et al., 2010) and decrease the probability of habitual thinking (Xu & Pang, 2020), it can also require greater levels of cognitive effort. Further, individual difference variables, such as the personal need for structure, may lead to variation in the benefits of cognitive stimulation (Goclowska et al., 2014). In agreement with this, the greater an individual's ability to tolerate the ambiguity of diverse and inconsistent cues, the more likely they are to be creative (Zenasni et al., 2008).

Further complicating the picture, individual differences in web searching strategies are complex and multiple and there is little evidence to suggest how these may interact with

the needs of the creative process. Lack of domain knowledge, lack of web search experience, advanced age, lack of cognitive flexibility, lower working memory capacity, and lower levels of intelligence have all been found to negatively affect the outcomes of web search (Dinet et al., 2012; Nori et al., 2020; Sharit et al., 2008). An individual's cognitive style has been found to be a factor, but the lack of a consistent use of terminology and cognitive measures makes it hard to draw definitive conclusions (Lugli et al., 2017).

Further, as noted previously, the web can limit search space, promote fixation, and block better ideas (Bilalic et al., 2008; Marsh & Rajaram, 2019; Wiley, 1998). Exposure to external information can also reduce the ability to retrieve internal information (Storm, 2019) and challenge individual differences in the ability to overcome knowledge constraints (Smith, Ward & Schumacher, 1993). Therefore, the presence of external stimuli provided by the web may not be a sufficient condition for enhancing creative idea generation, and relying solely on external sources and outward perceptual processing may limit originality if creators do not combine this with inward processing and their individual, idiosyncratic knowledge and experience (George & Wiley, 2020; Van Dijk et al., 2020).

In sum, as a source of cognitive stimulation in the creative process, the web affords the potential sharing and exchanging of knowledge and ideas that could enhance idea generation, providing access to an extended associative network that is never the same twice, and is different to one's own. However, when using the web in the 'real world' to search for information, the process may be more about creators having the resources to maintain the cognitive effort required when attending to and selecting information and ideas that they find stimulating and/or relevant. That is, information and ideas that cohere or react with a creator's own idiosyncratic mental models of a problem space and a solution space. Further, stimulus input must fit the cognitive needs of the individual or the stimuli

may result in negative consequences such as idea fixation (Vasconcelos & Crilly, 2015; George & Wiley, 2020), or lower levels of originality (van Dijk et al., 2020). Further research is needed to compare the interaction between the individual difference profiles of creators and web search, as well as exploring whether the web can help overcome individual differences that may limit creative outcomes.

Reflecting/Evaluating

Choosing the form of the problem requiring a solution, the most useful knowledge and information from which an idea can be formed, or the most creative ideas all require evaluative processes. Evaluation decisions are made in the context of the creator's internalised model of the specific task and are made at all stages of the creative process (Sawyer, 2012). Most models of the creative process include terms that indicate evaluation. For example, Wallas' use of 'verification' (1926), or the use of 'exploration' in the Genoplore model (Finke et al., 1992).

Cognitive acts elicit feelings (Flavell, 1979; Puente-Diaz et al., 2020), which are often used as heuristic evaluative cues in the absence of an awareness of cognitive processing (Ackerman, 2019). For instance, subjective, intuitive experiences such as insight and the feeling of rightness are heuristic sources of information that people regularly use to inform decisions and judgements (Laukkonen et al., 2018) and they share many common phenomenological and experiential factors. A feeling of rightness is a metacognitive judgement that is thought to be a determining factor in the amount of effort put into the cognitive task at hand (Ackerman, 2019; Thompson et al., 2011), acting as a bridge between Type 1 and Type 2 thinking processes. The speed with which a solution comes to mind

predicts a greater feeling of rightness and (over) confidence in a response (Thompson et al, 2013; Wang & Thompson, 2019), regardless of how correct the response is. A strong feeling of rightness can signal termination of analytic thinking, because the intuitive response is 'right' (Ackerman & Thompson, 2018). . Conversely, responses that take more time and require more deliberative processing or where information is conflicting or unfamiliar, are associated with a lesser feeling of rightness, less confidence and may stimulate Type 2 processing. However, as time passes, people become more likely to satisfice as the cost of further deliberation becomes too high and the feeling of rightness too low (Simon, 1979; Ackerman et al 2020).

Metacognitive monitoring provides a way to assess the overall progress and output of cognitive processes (Ackerman, 2019; Ackerman et al., 2018; Gambetti et al., 2020), constantly adjusting cognitive strategies as the gap between the current state and the target state of the cognitive task is evaluated. Metacognitive monitoring and evaluation could underpin Nijstad *et al*'s (2010) 'idea monitor', which constantly checks generated ideas during a creative process. Individual differences in thinking styles, such as a preference for rationality (Epstein & Pacini, 1996), are thought to interact with metacognitive processing. For instance, rationality creates confidence and consciousness of strengths and weaknesses in reasoning, bringing an awareness of both intuitive and non-intuitive response options. This allows better choices to be made (Gambetti et al., 2020), and provides a greater ability to over-ride intuitive, potentially sub-optimal, responses. In contrast, an experiential thinking style has been found to increase the attention given to metacognitive feelings in decision making about creative ideas (Puente-Diaz et al., 2020).

Research suggests that creative evaluation that integrates cognitive and affective, deliberate and spontaneous forms of evaluative thought is more effective (Ellamil et al.,

2012; Puente-Diaz et al., 2020). Purely deliberative, analytical evaluation can easily become 'over-evaluation' reducing originality by discounting ideas which may be risky or too novel, and focused more on usefulness or effectiveness than on originality and novelty (Blair & Mumford, 2007). Conversely, more intuitive, affective, and spontaneous evaluation can have a positive effect on the selection of more creative ideas (e.g. Calic et al., 2020). Indeed, analytical processing of affective, heuristic responses has been found to predict higher levels of creativity (Pringle & Sowden, 2017).

Using search engines, in theory, may help the process of combining intuitive and more analytical evaluative processes. The list format of results allows for rapid, intuitive visual scanning for information and links to websites that may provide relevant information for further in-depth processing (e.g. Ong et al., 2017; Salmeron et al., 2017). Unfortunately, the pertinent cues in link content summaries, which are designed to persuade the searcher of relevance, link quality and accuracy, may challenge any perceived need for more sophisticated searching (Smith & Rieh, 2019). Furthermore, when presented with an overload of information (Khaleel et al., 2020; Swar et al., 2017), such as a long list of search results, searchers are more likely to evaluate search results heuristically in order to minimise cognitive effort and time spent (Hahnel et al., 2018; Wirth et al., 2007). These heuristics can be multiple and overlapping. For example, favouring the familiar, favouring information which is endorsed by others, favouring information which is consistent across a number of sources, favouring information which confirms existing beliefs or opinions, favouring sources which conform to appearance or functionality expectations. Often heuristics are adaptive and sufficiently efficient (Wirth et al., 2007), but they may limit exposure to novelty. Lack of individual motivation and persistence in the search enterprise may make satisficing more likely, as over-riding intuitive evaluation may be more effortful

and time consuming. Whilst this might suffice for simple 'look up' tasks that require little more than visual scanning of link summaries to find answers, more complex exploratory search tasks require more cognitively demanding processing and complex navigational behaviours in order to integrate and synthesise information from different sources (Sharit et al., 2008). This may draw more on Type 2 thinking processes and favour the more persistent and rational thinker.

A further challenge is that the speed at which the web provides answers to search queries may increase subjective feeling of rightness, and equation with the quality of information retrieved (Risko et al., 2016; Stone & Storm, 2019) prompting less Type 2 thinking process engagement, errors in evaluation, premature termination of searching and satisficing. Although there has been some research on the extent to which retrieval fluency effects extend to the internet as a transactive memory partner (Stone & Storm, 2019), more research on a broader range of retrieval fluency effects would be informative. In addition, research suggests that individuals with a deficit in perceptual speed, process fewer results on search engine results pages, and that individuals with relatively poor working memory have difficulty with concurrently searching for and processing information whilst keeping in mind any overall strategy and relevant mental models of search intentions (Sharit et al., 2008). This suggests that potential gains in the speed of the creative process using the web may not be available to all individuals, and the complexity of the creative search process may be too demanding to be of benefit to others.

In summary, the web has the potential to scaffold efforts to combine intuitive, heuristic evaluations with more in-depth, analytical and thoughtful evaluation, but this comes at a cost in terms of the cognitive and metacognitive effort and persistence needed to over-ride heuristic responses that may limit creativity. In a web context it seems likely

that evaluation of all kinds begins as soon as the first search query is generated. However, more research on this and other creative sub-processes in a web context would illuminate differences. The constant evaluation and review that takes place during the search process should stimulate learning, potentially leading to more effective idea generation and selection. Individuals may find evaluating the ideas of others to be a stimulating starting point for their own idea generation, but it seems likely that individual differences in motivation, persistence, cognitive flexibility and a preference for rational or experiential thinking will play a significant role.

Conclusion

There remains a complex set of limitations on the potential success of individuals using 'standard' web search to support everyday creative thinking and creative idea generation. In the two-way flow of information from user to and from the web, the human remains the critical component, (Heersmink & Sutton, 2020; Nestojko et al., 2013; Yamashiro, 2019), the ultimate evaluator, and most essential part of the creative process (Kantsalo & Toivenen, 2016); the web does not offer up its riches easily (Storm, 2019). It may be that using the web can effectively scaffold some parts of the creative process: more pro-active and rapid combining of preparation, enquiry and information search processes seems possible; more knowledge and information is available to an individual searcher than they would otherwise have access to from their own memory; existing ideas can be found which can be honed to new purposes in new contexts. Further, evaluative aspects of the creative process may be more emphasised suggesting a benefit for individuals with greater strength in the application of these processes. In addition, the web provides information in

a format which prompts both intuitive and analytical evaluation, and appears to prompt metacognitive monitoring and evaluation effectively. The lack of research in this area makes most conclusions speculative, but certainly worthy of further attention as differences in the creative process seem conceivable. Whether using the web as a supportive partner in a creative enterprise makes creative failure more or less likely remains an open question.

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