DID FISHING NETS WITH CALCULATED SHELL WEIGHTS PRECEDE THE BOW AND ARROW? DIGITALLY EDITED PHOTOGRAPHS MODEL ANOTHER USE FOR PREHISTORIC PUNCTURED SHELLS AND EARLY MATHEMATICAL ABILITY

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ABSTRACT

As tools, digital *photographs produce a mental event reshaping perception, generating a use-wear redescription of prehistoric people calculating shell net weight systems of at least ten grams. String is essential in making fishing nets with weights. We address how altered photographs can create false memories, and show that strategically reconfiguring digital shell images, in alignment with prehistoric tool use-wear studies, a better visual guide is introduced. This might explain associated precuneus brain evolution involved in bimanual processes, mathematical calculations, and spatial thinking, preceding by about 30,000 years the bow and arrow. As etched on the Blombos ochre stone, in figure 1, the net had to have a diamond shape to which a string of shells was attached, preventing shells from entangling. Digital editing, in figure 2,then helps us mirror the prehistoric cognitive style and visual grammar describing how the net would look in figure 3.*

KEYWORDS

Archaeology, Photograph, Precuneus, Shell Weights, String, Synthetic Memory, Use-Wear

1. INTRODUCTION

We propose that prehistoric punctured Nassarius shells, found in coastal areas such as South Africa's Blombos cave (BBC), functioned as shell net weights, providing a shell arrangement of at least the necessary ten grams in total, to partially sink a net, indicating already a mental system capable of calculating ten grams[1]. Nassarius shells, in bundles of a dozen or so, with rough punctures, were found as prehistoric artifacts in South Africa's and Israel's seaside caves. These are not to be confused with the more common and shiny cowrie shells later used in Africa for trade beads and body ornamentation. Shell net weights, like Nassarius shells, are tools in fishing, weighing a net below the waterline. It has been accepted, in cognitive archaeology, that interaction with tools, like interaction with photographs, can alter thinking. Thus our premise that the statement "brains make tools must be at least supplemented by the idea that tools can also make minds", such as the first minds capable of mathematical reasoning and net engineering [2]. Our research question is thus, is a redescription of the tool use, rather than century old "bead" ascription ornamental use of Blombos punctured shells, possible [3]? In 2009 Christopher Henshilwood published a report stating that Blombos cave was unusual for the variety and quantity of fish fossils, high in potassium for brain growth and evolution, found inside the cave, where inhabitants worked and lived. The fish remains were not obviously thrown back into the

water, perhaps to not attract predators. “Fish are seldom recorded at other southern African MSA [Middle Stone Age] sites, and by implication, it was thought MSA people were unable to exploit coastal resources effectively” [4]. The 2009 report states that nets and lures might have been utilized by the unique inhabitants of the BBC. “More than 1200 fish bones have been recovered from the MSA and occur in all the phases M1, M2 & M3. This means that people living at Blombos Cave had probably started fishing at least 140 000 years ago” [5].It is proposed in this article that these punctured Nassarius shells, found in close proximity to diamond shaped net designs inscribed in BBC ochre stones (figure 1), and large quantities of discarded fish bones, are also among the earliest evidence of string based fishing tools, mathematically calculated in groups of a dozen or more evenly distributed shells, to weigh at least ten grams to submerge a net.

Figure 1. Prehistoric 75,000 years old (kya) net engraving on ochre stone from Blombos cave, South Africa, photographed by Christopher Henshilwood, PhD [6]

This is pertinent since Bar-Yosef Mayer, et al, in 2020 write "that sometime within the time range of 160 and 120 kya BP the technology for making strings emerged" [7].The engraved stones themselves, if representing how to string a net, seem to act as a past grammatical visual or net making calculating unit evolved with tool use, indicating a diamond shaped fishing net, based on the abundance of fish fossils from mass fishing found in the cave. The reinterpretation of the Blombos engraved ochre stone as a casting style net, rather than a ladder or abstract symbol, is the symbolic point re-shifting the evolutionary visual matrix in cognitive representations in cognitive archaeology and mathematical thinking. The two research methodologies used here were effective persuading a scientific European conference audience, the European Association of Archaeologists (EAA) 2024 meeting in Rome, Italy, attracting an offer from an eye tracking laboratory to test our hypothesis, and a successful research abstract publication from our Computer Applications in Archaeology conference in May 2025 in Athens, Greece [8].The hypothesis has also been accepted for a more rigorous quantitative methodology presentation at the September 2025 conference at EAA in Belgrade, Serbia at session #58, “Digital tools for surface analysis of archaeological artifacts: integrating qualitative and quantitative approaches”. Generating acceptance of the shell weight hypothesis, in the early evolution of mathematical abilities, requires creating a visual campaign, through institutional media, producing and publishing a shell weight and net image stimulating the mirror neurons of the contemporary cognitive style, which we have done here, to mirror, or mimic that of the prehistoric visual unit cognitive style that would have logically calculated the prehistoric use of punctured shells as net weights [9].

2. METHODOLOGY

Two quantitative methodologies were used,1. computer calculated use-wear analyses of arrangement of punctured shells on string from the Blombos coastal cave (figure 2), compared with shells later American prehistoric sites, and 2. a measured photographic digital reconstruction method generating a mental visual convergence, or a synthetic memory (figure 3),based on available scientific data. The goal is to have audiences mirror the prehistoric cognitive style, and generate agreement regarding our proposed tool use of the punctured prehistoric Nassarius shells. The materials specifically used are the measures of prehistoric American punctured shell net weights, from Florida and Puerto Rico, found to share the same unique qualities and weight distribution measures as the prehistoric BBC Nassarius punctured shells. The use-wear based stringed and knotted arrangement of the Blombos shells photograph was then digitally transposed to the approximate points and similar dimensions of prehistoric American punctured shell weights on a net, in figure 2 on the next page, using as background a photograph of an American prehistoric fishing net, since no earlier African prehistoric nets have been found. The digital photographic computer editing was strategically accomplished generating in figure 2 a synthetic memory, a kind of cognitive visual image, from the past. The goal of generating a synthetic memory in digital photography is to stimulate the effects of a visual in altering the mental image and interpretation of the use of punctured Blombos shells. Based on cellular biology and memory case studies, repeated or prolonged exposure to a digitally generated synthetic memory reorganizes the neuronal connections associated with mental visual units, assuming there is survivability in the environment, of a visual grammar, or mathematical unit, of the subconscious, as part of the brain's memory processing. According to cellular biology case studies, transposed synthetic memories can potentially last generationally[10]. The first generation is exposed to a synthetic memory, adapting and passing on the evolved memory. Obtaining access to re-photograph and rearrange museum or institutionally stored punctured prehistoric Nassarius shells, with the few available prehistoric net artifacts, is costly and difficult. Thus addressing and clarifying the photographs of strung Nassarius perforated shells, at the moment, requires digitally altering photographs to visualize the shells not as beads[11], though as net weights organized, loosely or with a knot,on a string. The goal of this initiative is to obtain support to further test the digitally generated punctured shell and string synthetic memory, and eye-tracking behaviors, to then create physically a punctured shell weight fishing net system assumed to have been used by prehistoric BBC inhabitants. Evidence from the prehistoric American continent supports the reinterpretation that prehistoric African coastal populations at Blombos cave, and elsewhere, used these punctured Nassarius shells as net weights, with a cognitive system capable of calculating a minimal requirement of ten grams distributed with the shell weight arrangements [12]. Establishing this alternative redescription, based on available use-wear studies, requires recruiting prehistoric net casting expertise, project funding, and a special museum, educational, and media campaign in the form of publishing and implementing a digitally generated photograph, or synthetic memory, campaign.

3. RESULTS

The two methodologies of 1. comparative coastal prehistoric shell use-wear analyses, and 2. photographic digital reconstruction generating a synthetic memory to gain consensus regarding the tool use of punctured shells as net weights, were accepted at Silvia Stein’s presentation at the European Association of Archaeologists conference. Additionally, an offer was made to test the hypothesis that changing how persons see the punctured shells influences their description of the prehistoric shells use, resulting in the publication of this proposed research abstract in the Computer Applications in Archaeology 2025 catalog. Testing and measuring eye-tracking changes will require more digitally generated images, to attract adequate funding and expertise to

also understand the manual and cognitive needs in recreating an actual prehistoricreplica, with punctured Nassarius shell weights from the BBC, using local fibers or hair and ochre for the net string construction. Ochre traces were found on a few of the punctured Blombos shells and might have functioned, not as an adhesive, though as a dull camouflage coloring for the net attracting a particular fish. The participating audience at the previously mentioned EAA Rome 2024 and CAA Athens 2025 conferences agreed that Silvia Stein's presentation evidenced that the Skhul Cave, Israel bead use description does not account for the shell net weight use of Nassarius shells, when contrasted with the use-wear studies of the 75,000 kya Blombos cave, South Africa punctured Nassarius shells. Furthermore, it is documented that punctured Nassarius shells were made in large pre-stringed disposable quantities, thus not as precious ornaments or necklaces, though for being quickly detached from the net, thrown away, replaced, and a new string of a dozen or more shells attached to the net for mass fishing. "[M]aking, using, and discarding tools as an implicit part of behaviors associated with things like obtaining food"[13].

The supportive evidence for the net weight use of the Nassarius shells is based on 1. contrasting use-wear patterns of shells and their uses from different sites, 2. the proximity of the Blombos Nassarius shells, such as in figure 2, to recent discoveries of diamond and not square fishnet like etchings or visual grammar units, acting as a cognitive extension in ochre stone engraving, figure 1, in close proximity to the shells found in the BBC, and 3. a computer generated visual presentation of a synthetic memory, figure 2.Figure 2 bridges the memory gap in archaeology, stimulating the brain's mirror neurons to rehearse the visual logic of the synthetic memory generating new neuronal connections of the brain forming a correlational relationship to the Middle Stone Age brain, as part of the extended mind concept in cognitive archaeology and predictive theory building. Expanding on the communication studies value of "2."regarding proximity, as described above, the proximity of shells to net etched stones, articulates that two or more visual units, such as punctured shells (figure 2) and net engraved Blombos stones (figure 1), are grammatically identified as nouns, and together, in proximity, form an action or verb emerging as a motif with meaning potential or agency in early mythological, or image based, cognitive styles. Thus, a suspended motif in brain waves is formed or elicited [14], as a form of visualization time travel, a little out of focus or incomplete, like figure 2,a synthetic memory image, back in time.

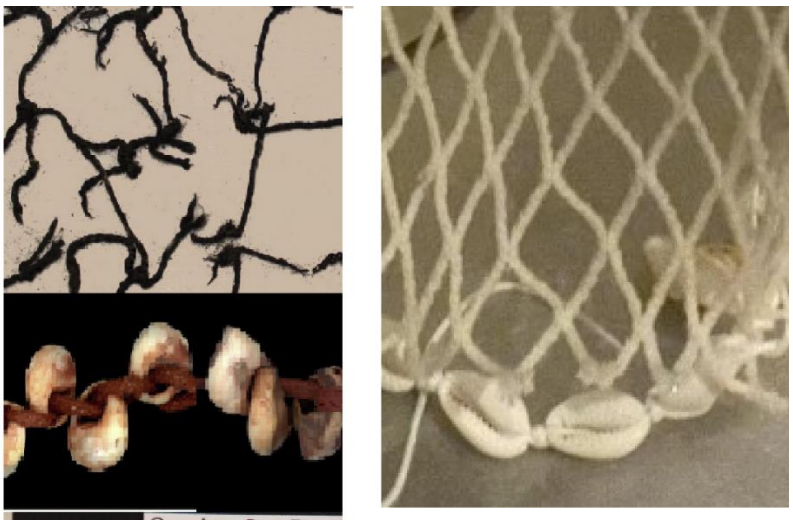

Figure 2 and 3

Figures 2 and 3 above are digitally created by Silvia Stein using photograph [15] of Nassarius shells arranged on a prehistoric net (figure 2) [16], according to calculated use-wear results to

hand make a small fishing net with small cowrie shells (figure 3), each shell not more than a centimeter in length. We were not able to find similarly sized Nassarius shells to arrange as shell weights, from amazon.com, thus easily available cowrie shells were used. The shells are arranged so as to provide a minimal net weight system of ten grams per twelve or thirteen shells. The net is created from a KUNGSFORS, a tiny hand held string purse net from IKEA.

The lack of focus, or the sensation of a missing detail, such as in figure 2, seems to be the essential mental cue for the observer, to then fill in for themselves the details, using their own working memory. An example is using the dis-attached portion of the prehistoric net in figure 2 to leave open the option for other geometrical string weaving forms, to stimulate memory – resulting in the tested diamond net weaving shape in figure 3. From this timeless sensation, without utilizing aids for an augmented reality, we often simply ascribe an aesthetic or spiritual value to objects we do not yet understand the functional or symbolic use of, "sinceneither cognition nor behavior can be directly observed or tested in extinct species" [17].

4. DISCUSSION

Redescribing, by digitally reimaging in figure 2, punctured Nassarius shells as functional tools could lead to significant shifts in the understanding of early human tool making behavior and mathematical creativity. This would prompt museums and academic institutions to adjust their presentations and research regarding these artefacts. Rather than showcasing shells solely as beads, institutions would need to highlight their significance as tools too. Thus, besides 1. comparing use-wear measurements from various prehistoric archaeological sites, to understand their tool use, 2. a visual aid strategy, such as digitally produced synthetic images bridging present thinking to prehistoric thinking, can facilitate our redescribing their use as net weights, and further curiosity regarding early human ingenuity and brain evolution of the precuneus. Before the time of the invention of the bow and arrow, 60,000 kya, which involves the invention of string, there was an enlargement of the human brain's parietal lobe which includes the precuneus, around 105,000 kya. The precuneus involves symbolic thinking about distances of numerical value to throw or set a net in depth away from shore, ratios of punctured shell net weights required to catch a meal of one or several fish (i.e. thirteen shell weights, totaling ten grams, are required to net one Roman Seabream fish),and strategic net bimanual constructions[18]. The parietal lobe, consisting of the precuneus, "is recruited for both finger movements and mathematical tasks. The importance of such parietal functions to both toolsand concepts is significant, given that parietal enlargement is the single characteristic best differentiating the human brain from the brains of other primates" in the evolution of cognitive mathematical and weight calculation abilities [19].The invention of string, thus, is the essential tool in the fishing net with shell weights (100,000 kya to 74,000 kya), preceding the invention of the bow and arrow (60,000 kya).The use-wear studies of the punctured Blombos Nassarius shells have clearly established that the shells were strung either loosely or knotted, perhaps for quick horizontally stringed shells replacement on nets for mass fishing, before the invention of the bow and arrow hunting a single prey. Thus, essential, is that use-wear studies indicate that the dull Nassarius perforated shells were strung not in a curve or loop for functions as a bracelet, or necklace, though horizontally as a string of shell weights to be affixed to the bottom of a fishing net. Our argument then heavily relies on these use-wear studies of shells horizontally on a string, essential to making fishing nets, preceding bow and arrow in brain evolution.

Moreover, considering that photographs play a crucial role in shaping and even generating synthetic memories by altering cognitive perception through repeated exposure, in the context of this study, digitally manipulated images have been used to transform contemporary descriptions of the use of punctured Nassarius shells. This process mirrors psychological research demonstrating how fabricated or altered photographs can create false memories, leading

individuals to recall events that never occurred. Our intention isnot to create a false memory, though to build upon scholarly studies to visualize a better understanding. “Over the last 40 years there has been growing interest in the idea that language and tools coevolved”[20], and by using the Blombos etched stone (figure 1), as a visual indicator to generate a digital reconstruction of the net use of the punctured shells (figure 2), as evident by the then resulting replica of a functioning diamond shaped net with shell weights, this technique seems justified (figure 3). By strategically reconfiguring images of shell artifacts to align with prehistoric tool use, a synthetic memory is introduced as a bridge, assigning meaning much like the Blombos diamond pattern net engraving etched into ochre stone in figure 1, providing a visual grammar or mathematically arranged unit, our missinglink, from prehistoric South Africa describing the process to tool making, potentially reshaping archaeological consensus on the origins of mathematical, particularly geometric, thinking. This visual technique influences scholarly discourse in mathematics and archaeology, consequently impacting public and institutional narratives, fostering acceptance of alternative interpretations based on prehistoric weight distribution calculations in fishing, with a net, consistent with use-wear findings of calculated shell arrangements and their exposure to salty water [21 and 22].

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