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Going to Pieces: Investigating the Deliberate Destruction of Late Bronze Age Swords and Spearheads

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The deliberate destruction of Late Bronze Age swords and spearheads has been widely recognised across Europe. This observation has typically relied on the obvious nature of the destruction, such as the bending of blades or the crushing of sockets, and the association of multiple broken pieces. These obvious acts have been used to interpret the material in sacred or profane terms without due consideration of how the objects were destroyed. This paper presents experimental research exploring how swords and spearheads may have been intentionally damaged in the Bronze Age. The results of these experiments are compared with artefacts from across Britain, making it possible to better identify and analyse deliberately destroyed objects. A series of implications for how one may more accurately interpret the wider archaeological record is presented.

Keywords: Fragmentation, experimental archaeology, Bronze Age metalwork, swords, spearheads

The deposition of intentionally destroyed swords and spearheads is frequently encountered in Late Bronze Age contexts across Europe (Nebelsick 2000; York 2002; Turner 2010a; Rezi 2011). Swords and spearheads are often broken, bent, and crushed prior to deposition; the obvious nature of much deliberate damage means traditionally the focus has been on *why* these objects were destroyed. This is broadly considered to have been undertaken for two purposes: functional destruction, such as recycling, or sacrificial destruction, such as an offering (Needham 2001). These conclusions are typically drawn based on the condition and context of the artefacts. Late Bronze Age hoards of fragmentary material, for instance, are typically referred to as 'scrap' hoards (Burgess 1968, 17ff.; Bradley 2013; Wiseman 2018). Meanwhile, broken swords and spearheads from watery contexts are considered more likely to be linked with votive practices (Burgess 1980, 351; York 2002). This debate is well established (Barrett & Needham 1988; Bradley 1998, 114–29; 2013; Needham 2001). Whilst the importance of the context in which these objects were found cannot be denied, I will illustrate in this paper that such interpretations also need to incorporate an understanding of *how* the objects were damaged.

There is, for instance, little understanding of the damage that might be caused to objects such as swords and spears through use, despite recent use-experiments (eg, Molloy 2007; Anderson 2011). This is because it is often not recorded – at least not in published material. It is thus possible that some ancient damage that is considered 'deliberate' may in fact be the result of use. Where objects show obvious indicators of deliberate destruction, it is similarly important to understand the practices involved in breaking, bending, and crushing metal implements. By appreciating these processes, one can begin to infer whether they required specialist knowledge, equipment, or skills and, by extension, the types of individuals who may have been involved, such as metalworkers. Further to this, we can develop an understanding of the biography of an object or group of objects immediately prior to deposition. This can then help us understand why they may have been deliberately damaged in the first place and whether this might be linked to functional or sacrificial rationales.

This paper therefore presents a series of experiments conducted on replica bronze swords and spearheads from Devon and Cornwall, south-west England, to firstly explore damage that might occur through use, and secondly to test different methods for destroying these objects. The results are then compared with archaeological specimens from Britain, followed by

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a discussion of the wider implications for identifying destructive practices and interpreting the reasons for intentional damage. This paper focuses specifically on swords and spearheads, which are often found deliberately destroyed in the Late Bronze Age, but complements other destructive experiments conducted on socketed axes (Knight 2019). This paper concludes with directions for future research.

IDENTIFYING DELIBERATE DESTRUCTION

The methods traditionally used to identify deliberately destroyed Bronze Age metalwork have often been subjective. Interpretations may have relied partly on the context (eg, destroyed metalwork from an irretrievable bog deposit versus a retrievable dry land hoard), but they were largely influenced by the 'obvious' nature of a destructive act (eg, Nebelsick 2000) – a sword bent into a U-shape or a crushed spearhead socket was clearly intentionally destroyed. However, where the cause of damage is less obvious, as in the case of isolated fragments of swords or spearheads, the possibility that they too were the result of deliberate action is rarely considered. Fragmentation analyses have attempted to tackle this issue by identifying patterns in the pieces that survive archaeologically and by trends in depositional locations (Chapman 2000; Bradley 2005, 145–64). Such an approach has yet to be applied with any rigour to Bronze Age metalwork in Britain, though systematic studies of metalwork fragmentation in Bronze Age hoards in Romania (Rezi 2011) and northern Europe (Čivilytė 2009) have proven insightful in understanding patterns of damage and selective depositional practices. This highlights a need for a structured approach to the identification of intentionally damaged Bronze Age metalwork, which could in turn aid how the phenomenon is interpreted. Such a methodological undertaking is beyond the confines of this paper, but experimental activities should be considered instrumental in developing a more objective identification process. This inherently involves not only understanding the use and destruction of the objects, but also the underlying material properties that govern the behaviour of the bronze.

Bronze in the Late Bronze Age is typically composed of copper alloyed with various percentages of tin and lead (Allen *et al.* 1970; Northover 1980). Generally, bronze displays some plasticity and ductility (ie it will bend before breaking), but differences in the proportions of these elements result in different mechanical properties of the resulting copper alloy (Staniaszek & Northover 1983). A higher tin percentage will produce a harder but more brittle copper alloy, while more than 5% lead can lower the tensile strength (ie the maximum stress a material can withstand before fracturing) (Tylecote as quoted in Allen *et al.* 1970, 22–23; Copper Development Association Inc. 2017). Therefore, bronze objects with high levels of tin or lead may be more prone to breaking. The mechanical properties of bronze are increasingly integrated into understanding plastic deformation and use-wear of Bronze Age metalwork (Sáez & Lerma 2015; Horn & von Holstein 2017) and have been raised elsewhere as a factor in understanding deliberate destruction (Knight 2019).

The microstructure of bronze also means that it will harden as it is worked, which inversely lowers the plasticity and increases the brittleness. In real terms, what this means is that a work-hardened sword may have greater cutting power, but is less likely to bend under stress and more likely to break. The importance of understanding production and post-cast treatments of objects is thus also integral.

The impact of lead on the microstructure is particularly noteworthy, as lead is immiscible in a tin-copper mixture, which may make the bronze more prone to breaking (Staniaszek & Northover 1983; Craddock 1991, 55). This is because as the alloy cools following casting, the lead is segregated and solidifies in between the tin-copper grains of the microstructure creating planes of weakness (Staniaszek & Northover 1983; Scott 2012, 242). This becomes particularly evident at a macroscopic level when the bronze is heated and fractures – a process known as 'hot-shorting'. Hot-shorting occurs when the metal is heated past a certain temperature, causing fracturing under pressure (eg, a blunt force) and results in a sharp, 'clean' break (ie a straight separation of two pieces with limited associated deformation or further fragmentation) (Kuijpers 2014, 82). This is caused by the segregated lead having a lower melting point than the alloyed tin-copper mixture, increasingly the likelihood of fractures (Staniaszek & Northover 1983, 265). Therefore, if Bronze Age artefacts are known to be composed of leaded bronze and present a clean, sharp break, it is likely these breaks are the result of hot-shorting (Knight 2018, 44–5). Of course, the exact temperature at which this will occur is dependent on the composition and casting quality of the object, as well as the force with which the blade is struck, hence why working a sword edge through heating and annealing does not result in every sword breaking.

Clearly these various factors need to be understood in order to interpret broken bronze artefacts. Repeated impact on bronze (both during or after metalworking) will cause it to harden and become more brittle over time, and clearly there must have been a balance between heating a sword so that it could be annealed and work-hardened without hitting it to the point that it hot-short. Broken swords and spearheads demonstrating signs of extensive use or heavy working may have been broken as a result of these activities. One can strengthen this interpretation by considering various use-wear experiments. However, the results of use-wear experiments and the final condition of the objects have yet to be systematically applied in studies of fragmentation and damage. It is noteworthy that of the published experiments involving swords and spearheads, there are no recorded instances of breakage or significant damage; the use-wear that is usually recorded comprises plastic deformation of the edges (eg, Molloy 2007). Anderson (2012, 89), however, found that a replica bronze sword became bent when striking an animal carcass, and Crellin and colleagues refer to swords that bent during parrying actions in their Bronze Age Combat project (Crellin *et al.* 2018, 295). This included one sword that bent to the extent it was deemed unsafe to continue using it. (These experiments await full publication.) In another experiment, misuse of a replica Bronze Age sword as a chopping tool to cut down tree branches (rather than a weapon for combat) caused the blade to bend (Skallagrim 2014). The blade was quickly and easily straightened multiple times and continued to be used. The plastic properties of the bronze allowed for this process, and it was repeated several times without causing material failure. The replica sword was composed of 12% tin and 88% copper, broadly consistent with prehistoric tin-bronze examples. Although this latter experiment was conducted for entertainment on YouTube, it emphasises the resilience of the material and contrasts with previously held views that Bronze Age swords which have bent 'can only be straightened once or twice without the aid of heat treatment before fatigue and internal flaws cause a fracture' (Molloy 2011, 75). This discrepancy is partly because of the length of time over which experiments are conducted, and also the research aims of the experiments, which tend to focus on best practice for using the objects (and not necessarily use-related damages). It is unlikely that a short period of use would result in the material failure of a bronze sword or spearhead.

An untapped avenue is experiments investigating methods of prehistoric destruction. Presently, this type of experimentation is small in scale with a narrow focus, is largely unpublished (eg, Hardman 2016), or sits as addenda to larger papers (eg, Giardino & Verly 2013, 167–9). However, destruction experiments have the potential to offer key insights into the processes that preceded the deposition of objects, as well as to challenge preconceived notions of the properties of particular materials (cf. Knight 2019).

Giardino and Verly (2013, 167–9) set out to test if 'reverse quenching' a sword following annealing would improve its malleability to transversely bend into a U-shape, and they found that the technique used to bend the sword was the more important factor. When bent over a steel anvil, the quenched sword broke over the point where the stress was greatest. By contrast, it was possible to bend an unquenched sword into a U-shape without causing it to break when the sword was bent manually over the experimenter's thigh with the pressure more evenly distributed. The authors concluded that a good material knowledge was necessary to successfully manipulate a sword without also causing breakage (Giardino & Verly 2013, 169).

Hardman (2016) produced a series of tin-bronze bars about the width and thickness of sword blades and broke these at different temperatures. This demonstrated that as the temperature increased, the angle of deformation (ie the degree of bending) associated with breakage decreased (Hardman 2016, 18). The results were then compared with two Late Bronze Age hoards from Wales to suggest temperatures at which different artefacts were broken. It was concluded that a metalworking specialist was likely involved, or at least someone with access to metalworking equipment (Hardman 2016). However, as stated above, most Late Bronze Age copper alloys include some lead, which can have instrumental effects on the fragmentation process. The addition of lead lowers the temperature at which the bronze is prone to break and also enables hot-shorting. Further exploration utilising leaded copper alloys is required.

Finally, destruction experiments involving replica socketed axeheads have been conducted investigating the impact of heat and the use of different tools, and comparing them with archaeological artefacts from

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Cornwall (Knight 2019). I found that fragmenting a socketed axehead is easier when heated, regardless of the composition of the object or the tool used. From these experiments, I demonstrated how the replica fragments could be used as a reference collection for identifying deliberate destruction on damaged objects (Knight 2019). The current paper furthers this research by presenting a complementary experimental programme exploring other object types.

PILOT EXPERIMENTS INTO DESTRUCTION

To develop hypotheses for a programme of destructive experiments, several metalworkers were consulted to discuss destructive processes and undertake pilot experiments that could generate hypotheses. These were undertaken on an opportunistic basic with the materials available at the time so should be considered separately from the more targeted set of destruction experiments presented later in this paper. However, during the pilot research, it became apparent that the fragmentation of metal objects was well-understood by metalworkers and often conducted on an informal basis with no quantified approach.

For instance, public performances of bronze sword casting at the Montale Terramare open-air archaeological park, Italy, were followed by the fragmentation of the sword for recasting in the next public performance. The freshly cast sword was reheated in a fire and then struck with a blunt implement (Knight 2015); the colour of the sword (red and glowing) indicated the temperature at which it should be broken. The temperature was more important than the tool used to break the object. Antler, stone, and bone implements were all used to fragment the sword, demonstrating the heightened brittleness of bronze at high temperatures (Fig. 1). It is also noteworthy that no impact marks or associated damage (such as bending) were left by these tools, despite fragmenting the sword into multiple small pieces. Interestingly, the metalworking team at Montale had an inherent knowledge of how the material would behave.

Additional pilot experiments were conducted at Butser Ancient Farm involving two replica bronze swords with the experienced bronzecaster, Neil Burridge. One sword was composed of tin, lead, and copper, whilst the other was composed of only tin and copper. Therefore, this allowed some exploration of the effect of composition on fragmentation. Based on the colour of the metal, it was estimated that the swords fragmented at Montale were heated to approximately 550ºC, so the swords were heated to a similar temperature as measured by a temperature probe. It was possible to fragment the leaded-bronze sword quickly and efficiently using an oak baton, though it was necessary to heat the tin-bronze sword up to 650ºC before it could be broken. This also caused extensive bending and bowing of the latter blade, indicating that composition may affect the associated damage observed with breakage.

Fig. 1.
Breaking a replica bronze sword using an antler hammer

The results and information garnered from these experiments, coupled with the previous recorded experiments, thus indicated some of the variables that should be considered in developing an experimental programme, including the effect of temperature and composition on fragmentation.

EXPERIMENTAL DESTRUCTION

The pilot experiments demonstrated that some of the initial questions that might be answered through the present research, such as the most effective method for fragmenting a sword, were already largely understood by those who regularly engage with the material. However, in the published literature, this avenue has only ever been explored for swords via the two studies already discussed (Giardino & Verly 2013, 167–9; Hardman 2016). Spearheads have never been subjected to experimental destruction. Due to the infancy of such studies, the aims of the present experiments were necessarily modest. The key aim was to explore how swords and spearheads were deliberately

TABLE 1: DETAILS OF THE PRODUCTION OF THE REPLICA SWORDS AND SPEARHEADS

Object ID	*Object type*	*Copper %*	*Tin %*	*Lead %*	*Post-casting processes*
2.1	Sword	90	9	1	Unquenched Casting jet removed Edge ground, cold-hammered & sharpened Ash hilt riveted on
2.2	Sword	90	9	1	
2.3	Sword	90	8	2	Unquenched Casting jet removed Left as cast
3.1	Spearhead	88	10	2	Unquenched Casting jet removed Clay core inserted 2 m long ash shaft inserted & riveted
3.2	Spearhead	88	10	2	Unquenched Casting jet removed Core removed

damaged in the Bronze Age. This was done firstly by involving the objects in combat scenarios in which the objects were deliberately misused to simulate damage that may have occurred through accident in the past, and secondly by conducting deliberately destructive actions upon the objects. The misuse (or inappropriate use) of objects is here defined by their use in a manner that would not have utilised the implement to its greatest effect. The sword, for instance, is best utilised as a slashing and thrusting weapon. Similarly, the spear selected here is most appropriately used as a thrusting implement and is too heavy to have been used as a javelin. These deductions were made through conversations with the combatants involved and are also reflected in the damage sustained to the weapons following different modes of use (see below).

OBJECT DESIGN AND PRODUCTION

Three swords and two spearheads were produced based on examples from south-west England (Table 1). An inherent problem with selecting objects on which to base the replicas for this experimental work is that the main interest was in broken and damaged artefacts. This means that any reproductions would most likely be based on incomplete objects for which only fragmented pieces survive. Incomplete examples were chosen because they afforded the opportunity to test methods for reproducing comparable fragmentation. Complete specimens of incomplete artefacts were produced by studying similar contemporary artefacts and according to the expertise of the metalcaster: Neil

Fig. 2.
The fragmented sword from the St Erth hoard, Cornwall (photo: M.G. Knight courtesy of the Royal Institution of Cornwall)

Burridge. All objects were cast in sand moulds and limited post-casting processes were undertaken to reduce the variables that might affect breakage.

The swords were based upon an incomplete Ewart Park sword from St Erth Hoard I, Cornwall (Fig. 2). This hoard dates to *c.* 1000–800 BC and contains 27 pieces of broken metalwork, four of which refit to form the hilt and upper blade of a sword. Over a thousand Ewart Park type swords are known from Britain and Ireland (Colquhoun & Burgess 1988, 55), and of the 411 Ewart Park swords from Britain illustrated by Colquhoun and Burgess, 253 (61.5%) are broken or damaged. Of the sword replicas produced, one was left as cast, whilst two were hilted and sharpened (Fig. 3).

The spearheads were based upon incomplete examples from the Bloody Pool hoard, Devon (Fig. 4). This hoard contained three broken barbed spearheads, represented by five fragments, alongside an incomplete plain pegged spearhead, and four ferrule fragments (Tucker 1867, 120–1). These are presumed to have

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Fig. 3.
The two replica swords with handles

Fig. 4.
The Bloody Pool hoard, Devon (photo M.G. Knight courtesy of the RAMM, Exeter)

been deliberately broken (Brück 2015, 46), and barbed spearheads are frequently found in damaged and incomplete conditions across Britain (Davis 2015, pls 122, 126, 127). The specific technique for producing these conditions is rarely speculated. Of the two spearheads produced, one was hafted on a 2 m long ashwood shaft in preparation for use-experiments (Fig. 5).

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Fig. 5.
The hafted replica spearhead

THE COMBAT EXPERIMENTS

Combat experiments were conducted to investigate how use-related damage, such as bending and edge damage, might have occurred on swords and spearheads, and which may be misconstrued as deliberate damage on ancient artefacts. Although difficult to explore, it is important to consider that even when these weapons were used in prehistory, the expertise of the individuals wielding the weapons likely varied. It is conceivable that some swords display signs that may be indicative of individuals misusing their weapons due to inexperience or accident. Weariness over the course of a combat event may also have been a factor. These experiments were not intended to explore the complexities of sword and spear use, which has been adequately covered elsewhere (Molloy 2006; Anderson 2011). Therefore, the implements were subjected to actions that could simulate accidental damage during a combat incident, including plastic deformation of the sword edge (eg, notches) and bending of the blade. Material fatigue resulting in breakage may have occurred over time, but could not be explored in this short-term experiment.

The experiments involved two combatants (Tom Chadwick and Kelly Lake) possessing 18 years of weapons and stage combat experience between them. Although unfamiliar with Bronze Age implements, they understood weapons conceptually and how the original objects may have been used. The swords were used against each other, as well as against the spearhead and a replica medieval shield. Ideally, a replica Bronze Age shield would have been obtained to observe damage from the interaction between swords and shields, but this was not possible. Instead, Mr Chadwick provided a replica medieval kite-shaped shield made from three thin layers of curved ash wood planks coated with linen on the front and rawhide leather around the rim. Despite archaeological inaccuracies, this offered a model against which to observe possible use-damage resulting from sword-on-shield scenarios.

The nature of bronze means that 'edge-on-edge' combat may not have been the most effective method for using swords as it can cause extensive damage to the blades (Neil Burridge pers. comm.). Regardless, many ancient swords display edge damage indicating edge-on-edge contact. The two swords were consequently used in a variety of actions including:

Edge-on-edge
Edge-to-flat (of the blade)
Flat-to-flat
Edge-to-shield rim
Flat-to-shield rim
Edge-to-shield face
Sword edge-to-spearhead edge
Sword edge-to-spearhead flat
Sword edge-to-spear shaft.

These actions were the most likely to cause damage to the sword or spear as they involve the most forceful contact (ie metal-on-metal). They were conducted at differing forces and angles, which were conditioned

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TABLE 2: A SUMMARY OF THE ACTIONS UNDERTAKEN AS PART OF THE COMBAT EXPERIMENTS AND THE RESULTING DAMAGE

Action	*Damage*
Soft blows, edge-on-edge, Sword 2.1 hitting Sword 2.2	Swords 2.1 and 2.2: small 'v-shaped' nicks *c.* 0.5 mm deep over a 32 mm spread
Edge-on-edge, Sword 2.2 held out with Sword 2.1 swinging down (Soft)	Swords bit into each other causing tearing/bowing of Sword 2.2 and U-shaped notch (1.6 mm × 1.1 mm)
Edge-on-edge, Sword 2.2 held out with Sword 2.1 swinging down (Hard) – Disarmed combatant	Tearing of metal, U-shaped notches on both swords (Fig. 6) Sword 2.2 notch: 4.5 mm × 2.5 mm
Sword 2.2 swung across at upright Sword 2.1	Glancing strike, left no significant mark
Edge-on-edge, Sword 2.2 swinging down at Sword 2.1 (Hard)	Sword 2.2: shallow u-shaped notch
Edge-on-edge, Sword 2.1 down onto Sword 2.2	Sword 2.1 bit into damage previously sustained on Sword 2.2 e×panding a u-shaped notch and causing tearing (2.7 mm × 2.7 mm)
Sword 2.1 swung down, Sword 2.2 swung up – limited damage to both blades (slightly glancing) – not as hard	Sword 2: U-shaped notch: 3.8 mm × 1.2 mm
Flat-on-flat, Sword 2.1 down onto Sword 2.2	Sword 2.1 bent to *c.* 4°; Sword 2.2 bent to *c.* 6°
Both swords bent back into shape over the knees of the combatants.	No visible marks
Sword 2.1 edge onto Sword 2.2 flat	Scar across flat of Sword 2.2 (27.7 mm long, bowing of edge) (Fig. 7); Sword 2.2 bent in both directions (Fig. 8); Flattening of Sword 2.1 edge
Sword 1 onto shield rim	Cut into shield *c.* 5 mm
Sword 2.1 soft edge-strike on wooden shield	Some damage to paintwork and marks on shield; limited damage to Sword 2.1
Sword 2.1 flat versus shield edge	10° transverse bend
Spear 3.1 thrown three times; max reach was *c.* 10 m	No significant damage; dug into ground on second throw causing slight blunting of the tip
Sword 2.1 edge swung down onto spearhead edge	Deep tearing sword edge; V-shaped notching on Spearhead 3.1
Sword 2.1 edge swung down onto Spearhead 3.1 obverse face	Sword scar left along face of Spearhead 3.1; sword edge flattening
Sword 2.1 edge swung down onto spear shaft	Initial notch created in shaft, second strike broke shaft

by the combatants. Thus, precise forces and angles could not be measured, though a realistic set of bodily actions was replicated. The size and weight of the spear means it was probably predominantly used as a thrusting implement, and due to safety restrictions it could only be used in a limited manner against the sword.

Results and comparisons with the archaeological record

Table 2 summarises the actions undertaken and the damage present on the swords and spear during the experiments. Edge-on-edge strikes with the swords resulted in extensive notching and plastic deformation of the edges (Fig. 6), which was similarly seen when Sword 2.1 was struck against the edge of the spear. The notches on Sword 2.1 are up to 4.2 mm deep and can be paralleled with notched swords in the Blackmoor hoard, Hampshire. Extensive notching is seen on a variety of Bronze Age metal artefacts. Notched spearheads also occur in the Blackmoor hoard, and it is possible that some of this notching may have also been caused by a sword, judging by the similarity with Spearhead 3.1. It is important to note, however, that the notches created were much larger than is often seen on Bronze Age weapons. Crellin and colleagues make a similar observation about the weapons from their experiments; they suggest that this may be because such use experiments are intended to 'make marks' rather than truly being used for fighting (Crellin *et al.* 2018, 299). The same limitation can be levied against the experiments here.

To simulate inappropriate (and potentially accidental) use of the swords, less conventional tests were conducted involving the flat of the blades. This involved striking the flats against one another, parrying a sword edge with the flat of the blade, and

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Fig. 6.
Notches caused by edge-on-edge contact between the replica swords (Sword 2.1 above, Sword 2.2 below)

Fig. 7.
A negative scar on Sword 2.2

Fig. 8.
Sword 2.2 bent in both directions

striking the rim of a shield with the flat of Sword 2.1. In each scenario this resulted in transverse bending up to 10°. This bending, however, could easily be rectified in the field by the combatants straightening the blades over their knees. This emphasises how easily a bent sword might be repaired (though in a true combat situation it is unlikely one would be afforded the opportunity to correct their sword!). Striking the flat of Sword 2.2 with the edge of Sword 2.1 in a simulated parry caused the edge of Sword 2.1 to flatten slightly, and it produced a negative scar (ie an indentation of the edge that contacted the blade) on the flat of Sword 2.2 and bowed the edge of Sword 2.2 (Fig. 7). Additionally, Sword 2.2 bent in both directions causing a wave-like profile (Fig. 8), which may be misconstrued as intentional damage in the archaeological record. Anderson (2012, 89) similarly observed wave-like bending of a replica sword when striking a pig carcass. The wave-like profile can be paralleled with two swords recovered from the River Thames (Colquhoun & Burgess 1988, nos 197, 220), and these experiments suggest those swords may have bent as a result of use, rather than deliberate manipulation.

Conversely, the strikes involving Spearhead 3.1 were less insightful; no definite archaeological parallels for the damages that occurred could be identified. This is perhaps unsurprising, as barbed spearheads have often been considered as ceremonial, rather than combat, implements due to their size and limited indications of use (Burgess *et al.* 1972, 227; Davis 2015, 190).

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Fig. 9.
Sword 2.2 post-fragmentation

Significantly, none of the implements broke or were damaged to a point beyond function or repair. Prolonged or repeated use may produce alternative results, but currently these results align with the results of previous experiments.

DESTRUCTION EXPERIMENTS

Destruction experiments were undertaken to explore the effects of temperature and different tools and techniques on the damage and breakage of the swords and spearheads. Objects were heated in a small 'kiln' provided by Mr Burridge, with a probe used to record the temperature. A replica hafted bronze hammer and a replica bronze chisel were used to break the objects (the composition of these tools was 12% tin and 88% copper).

Swords 2.2 and 2.3 were utilised in these experiments as well as a mis-cast sword donated to the project by Mr Burridge, which offered the opportunity to observe whether casting quality (eg, air bubbles in the metallic structure) may affect how easily a sword might be fragmented. Sword 2.1 was retained with the use-damage for the purposes of future research. Both spearheads were used.

Experiment 1: Hot-shorting a sword

The pilot experiments showed that the most effective method for fragmenting a sword is to heat it and strike it. Experiment 1 aimed to heat a sword and explore the use of a hammer and chisel for controlling the size of the fragments produced. Controlling the size of the fragments would be beneficial for achieving a common size, which could be functionally advantageous for remelting in a crucible. Furthermore, as the sword is based on a fragmented artefact, it was hoped it would be possible to produce comparable fragmentation.

Sword 2.2 was heated to 575°C for over 40 minutes. This temperature was chosen based on previous experiments, which have demonstrated 500–600°C is an effective temperature range for fragmenting bronze objects (Knight 2015; 2019). Once heated, the sword was held with the tip projecting over a wooden block and struck with the hammer and chisel where the sword overlapped the block edge. Multiple strikes broke the sword into 12 hot-short fragments even as it cooled (Fig. 9). It was most effective to strike the projecting section of sword where it lacked support underneath. The hilt tang was fragmented following direct strikes with the hammer. Mis-strikes with the chisel left marks on the blade, though strikes that were successful in breaking the blade left no evidence that a chisel was utilised (Fig. 10). This therefore suggests that an individual skilled at using these tools and practised in fragmenting objects may not leave any archaeologically observable marks, or indeed have no need for a chisel at all.

Experiment 2: Bending an unheated sword

An unworked, mis-cast Ewart Park sword composed of 12% tin and 88% copper was used to explore the plasticity of a bronze sword and the extent to which it may be manually bent without the use of tools. Although unworked tin-bronzes have a high ductility, and are thus predisposed to plastic deformation rather than fracturing, it was hypothesised that it would be difficult to bend this sword without breaking it because of the porosity of the metal.

It was, however, possible to gradually apply pressure with my hands along the sword and bend it over my knee, distributing the stress to create an even U-shaped bend (Fig. 11). This was achieved without causing any breakage, demonstrating the plasticity of the material in an unworked form.

Experiment 3: Hammering a sword to cause plastic deformation

Sword 2.3 was used to explore whether hammering a sword to bend it would cause material failure and

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Fig. 10.
A fragment of Sword 2.2 with unsuccessful chisel blows at one end

Fig. 12.
Hammering Sword 2.3

Fig. 11.
An as-cast replica sword bent into a U-shape

breakage. Whilst gradual pressure was applied in Experiment 2, the hammer was used in this experiment to deliver concentrated blows to the sword. It was hypothesised this might cause breakage.

The sword was hammered in both directions resulting in multiple bends along the blade without any macroscopically visible signs of material weakness (Fig. 12). After an extended period of hammering, the sword fractured into seven fragments (Fig. 13). These fragments did not refit as easily as those resulting from Experiment 1, which is likely due to the loss of small fragments of bronze during the process (Neil Burridge pers. comm.).

Experiment 4: Striking a heated spearhead

Although Experiment 1 demonstrated that heating and striking a bronze object was the easiest way to achieve fragmentation, it was hypothesised the comparatively thicker nature of the barbed spearheads might affect the results. For instance, the body and

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Fig. 13.
Sword 2.3 post-fragmentation

Fig. 14.
Heated fragmentation of Spearhead 3.1

socket may crush rather than break. Experiments involving socketed axes had, however, already illustrated socketed objects might suffer extreme fragmentation too when subjected to heat (Knight 2019).

Spearhead 3.1 was heated to *c.* 560°C for over 35 minutes. As with the swords, the spearhead tip was positioned projecting over the edge of a block and struck directly with the bronze hammer (Fig. 14). Three strikes broke the spearhead into three pieces, requiring minimal effort (Fig. 15). The breaks occurred at slight angles across the blade, approximately where the spearhead protruded, meaning fragmentation was broadly controllable.

Experiment 5: Striking an unheated spearhead

The final experiment explored the effectiveness of trying to break an unheated spearhead with a hammer and chisel. Spearhead 3.2 had a casting flaw in the upper blade of one side, and it was anticipated this would increase the likelihood of the spearhead fragmenting. Sustained chiselling at the casting flaw caused an indentation and plastic deformation, but did not cause breakage. This method was therefore altered so the spearhead was struck directly with the hammer, which caused bending and eventual breakage of the tip, followed by crushing of the body and socket, and finally total fragmentation (Fig. 16).

Fig. 15.
Spearhead 3.1 post-fragmentation

Fig. 16.
Spearhead 3.2 post-fragmentation

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Results

The destruction experiments clearly demonstrate that heated fragmentation was quicker and more efficient than when the objects were left unheated, supporting the conclusions of other experiments (see Hardman 2016; Knight 2019) and the pilot experiments.

Heating the objects also reduced the amount of associated damage and indicators of destructive actions left on the objects by the tools used. Successful strikes with the chisel and hammer in Experiment 1 left no marks, whilst unsuccessful strikes caused surface deformation resulting in obvious chisel marks. The side profile of the sword remained unchanged, however, as the fragmentation caused no bending. The lack of marks and associated damage left by destructive actions on heated objects is particularly important – it raises questions about relying solely on 'obvious' marks of destruction (eg, hammer marks and plastic deformation) as a means for identifying it in the archaeological record. Deliberately destroyed objects may not show any signs of intent (cf. Knight 2019); the implications of this are explored further below. By contrast, extensive plastic deformation and surface damage was caused to the spearheads and swords that were left unheated.

Meanwhile, Experiment 2 demonstrated that an unheated, unworked bronze sword is plastic enough to bend over one's knee without fracturing, even with casting flaws. This confirms and furthers the conclusions drawn by Giardino and Verly (2013, 167–9).

Fig. 17.
A piece of Spearhead 3.1 (left) alongside a spearhead piece from the Bloody Pool hoard (right) (photos: M.G. Knight; right: courtesy of the RAMM, Exeter)

Comparisons with the archaeological record

The production of replicas based on broken artefacts offers the opportunity to compare directly the experimental results with the archaeological record. This can then suggest how the artefacts were broken in the past. The fragmentation of the St Erth sword and Bloody Pool spearheads was hypothesised to have been deliberate. These experiments not only confirm this theory, but also demonstrate how this was likely undertaken.

From Experiment 1, it is clear that the St Erth sword was broken by heating it and reducing it to fragments with a blunt implement. The lack of associated damage, such as hammer marks or bending, on the St Erth pieces means the sword was mostly likely hot-short, probably without the use of a chisel. Compositional analysis indicates the St Erth sword is predominantly a tin-bronze alloy, with less than 1% lead (Northover pers. comm.), which differs from the composition of the replica (see Table 1). Hardman's (2016) experiments showed that tin bronzes broken at very high temperatures showed limited plastic deformation, which suggests that the St Erth sword must have been broken at high temperatures due to the lack of associated bending. The overall fragmentation of the sword can be paralleled with the innumerable blade fragments that are recovered archaeologically, such as those in the Late Bronze Age hoards from Isleham (Cambridgeshire), Boughton Malherbe (Kent), and Stogursey (Somerset) (McNeil 1973; Colquhoun & Burgess 1988, plates 153–7; Adams 2016).

The heated fragmentation of Spearhead 3.1 is directly comparable with the Bloody Pool spearheads (Fig. 17), though not with the unheated fragmentation of Spearhead 3.2. Furthermore, the compositions used for the replicas were drawn from analysis of the originals (Northover pers. comm.). Therefore, the Bloody Pool spearheads were certainly deliberately broken while hot. This interpretation can also be projected onto other spearheads showing similar patterns of damage, such as the broken spearheads in the hoards from Broadness, Kent, or Winchester, Hampshire (Burgess *et al.* 1972, 264, fig. 21; Davis 2015, pl. 122).

Of course, some prehistoric metalwork was likely broken without the application of heat. However, the extreme plastic deformation and surface damage on Sword 2.3 is hard to parallel archaeologically, suggesting that the method of cold-hammering using a

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bronze hammer was considered inappropriate. It is possible that cold-annealing and hardening a sword during post-cast working may have broken the metal in some situations. The cold fragmentation of Spearhead 3.2, however, caused the body to crush and fragment. This can be paralleled with crushed spearhead sockets in some Late Bronze Age hoards, such as those from Stogursey, Somerset, and Wilburton, Cambridgeshire.

Similarly, finding comparisons for the bent sword resulting from Experiment 2 is problematic. Many of the swords depicted in Colquhoun and Burgess' (1988) *Prähistoriche Bronzefunde* volume are bent, but also broken. This difference between the unbroken experimental replica and the archaeological artefacts likely stems from the higher plasticity of the replica, resulting from the lack of post-casting hardening and working and the optimal tin-bronze composition. However, a bent, unbroken sword was recovered from Duddingston Loch, Edinburgh (NMS X.DQ 303), alongside burnt and unbroken bronze objects (Callander 1922, 360–4). The result of Experiment 2 means it is possible to suggest that implements like the Duddingston Loch sword were probably bent by hand while unheated.

DISCUSSION OF THE EXPERIMENTS

The experimental results offer a starting point for understanding the process of breakage and fragmentation in prehistory and how objects might suffer damage through misuse. However, these experiments were not without limitations, and due to the infancy of such studies, they were in many aspects exploratory. Nonetheless, they highlighted ways in which damage could be undertaken effectively, as well as techniques that were less effective.

Of particular note, it was clear that whilst fragmentation could be completed, it required knowing the correct method and process and was not as simple as bending and breaking a sword with one's bare hands or hitting a spearhead with a hammer. An element of skill and material knowledge was involved.

Similarly, these experiments offered the opportunity to consider the appropriateness of different tools. Although a chisel was used in Experiment 1, this was not essential, as striking the objects directly with a hammer was also effective. Where the use of a chisel did not break an object, it was possible to observe chisel marks on the eventual fragments, but successful breakages with the chisel or with the hammer left no associated damages. It is clear, therefore, that deliberate destruction need not leave any signs that might survive archaeologically. Where hammer and chisel marks have survived archaeologically, such as those on swords in the Late Bronze Age hoards from Grays Thurrock I, Essex, and Breage I, Cornwall (Turner 2010b, 31–8; Knight 2018, 378–9, fig. 9.32), the marks indicate narrower tools were used than those used in the experiments. There is clearly much scope for refining the experiments to achieve a more accurate replication of the prehistoric destruction of objects.

IMPLICATIONS FOR THE INTERPRETATION OF DAMAGED ARTEFACTS

We now have the opportunity to further the identification and interpretation of damaged and fragmented Bronze Age metal artefacts when they are encountered in the archaeological record. The combat experiments, for instance, highlighted how the misuse of the objects might cause the bending and notching often interpreted as the result of intent. Coupled with previous experiments that have similarly caused inadvertent plastic deformation of a sword (eg, Anderson 2012; Skallagrim 2014), these experiments emphasise the need for a more cautious interpretation of less extreme damage on archaeological artefacts.

The notching poses other interpretive issues. Previous use-wear studies have sought to replicate notching seen on blades and spearheads by deliberately striking edged metal objects against each other (eg, Bridgford 2000; Anderson 2011; O'Flaherty *et al.* 2011). On the other hand, potentially deliberate notching of blades is frequently noted on archaeological artefacts. For instance, Bridgford (1997, 106–7) refers to deliberately 'hacked' swords from Ireland, whilst O'Flaherty and colleagues suggest that the shape of the notch may relate to whether a blade was static or yielding when it was struck (O'Flaherty *et al.* 2011, 43). Meanwhile, the positioning of notches on the hilt of a Bronze Age sword from Werkhoven, Netherlands, possibly indicates the deliberate removal of the hilt (Fontijn *et al.* 2012). The parallel drawn above between the notching on the replicas and the notching observed on objects in the Blackmoor hoard could indicate that the Blackmoor objects were used with aggressive force to cause the notches. The notches on the Blackmoor spearheads certainly seem to indicate the spearheads were not used as one might

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Fig. 18.
The broken spearhead from Thurlestone, Devon (DEV-2B4697) (courtesy of the Portable Antiquities Scheme/Trustees of the British Museum)

presume (eg, in a thrusting or throwing manner). Additionally, many of the objects in the Blackmoor hoard have been deliberately broken and bent, so the intensive notching may have been part of the decommissioning process.

The destruction experiments illustrated that, similarly to use-wear studies, there is scope for using the results as the beginning of a reference collection for identifying deliberately damaged Bronze Age metalwork when signs of intent are less obvious. This was also demonstrated for Late Bronze Age socketed axeheads (Knight 2019). Previously, intent has been inferred from the obvious nature of destruction or by the interpretation of patterns of damage within a hoard (eg, Nebelsick 2000; York 2002; Melheim & Horn 2014).

The most significant contribution of this referential material is in identifying deliberate damage on single finds. Isolated fragments of Bronze Age swords, spearheads, and other metal objects are repeatedly recorded through the Portable Antiquities Scheme in England and Wales and the Treasure Trove System in Scotland. These often lack contextual information, and there is limited discussion on the nature of the object. Such finds are commonly interpreted as scrap metal or the result of accidental damage and loss. However, when fragments of sword blades or broken spearheads are encountered, it is now possible to begin interpreting whether the breakage is the result of intentional destruction or not by comparing it with the replica pieces.

For instance, an isolated Late Bronze Age spearhead from Thurlestone, Devon, is broken across the thickest part of the blade in a comparable way to the Bloody Pool spearheads and the heated replica (Fig. 18). It can be argued that this spearhead was the result of deliberate destruction following heating and fragmentation. A survey of the Portable Antiquities Scheme database revealed numerous broken pieces of spearheads that might be interpreted similarly across England and Wales. Meanwhile, although complete swords have historically been recovered from dryland contexts, there are currently no complete, unbroken swords recorded on the Portable Antiquities Scheme database.[1] However, many are represented by fragments comparable with the replicas.

Although similarities between the character of the archaeological pieces and the replicas do not prove conclusively that the broken swords and spearheads recorded are the result of deliberate fragmentation, it encourages a more careful interpretation of such

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objects when they are recovered. This is especially true as the destruction experiments did not always leave obvious signs of the method used, which means associated damage will not always be observable. For example, of the ten replica sword fragments that were broken using a chisel, nine displayed associated chisel marks. This may relate to whether or not the objects were broken on the first strike. Meanwhile, the fragments of the heated replica spearhead displayed no signs that they were struck with a broad metal hammer, nor did the hilt fragments of the heated sword. If we situate various isolated finds alongside each other, broader patterns of breakage can be developed and extrapolated to demonstrate that practices undertaken on a group of objects within a hoard may also be observable on single finds. Elsewhere I have shown that by analysing similar breakage points on socketed axeheads and comparing them with experimental replicas and evidence from hoards, one can interpret isolated fragments of socketed axehead cutting edges as the result of deliberate destruction rather than accidental breakage through use (Knight 2019). A similar study on swords and spearheads is not possible within the confines of this paper, but would repay visit in the future.

Understanding which finds were deliberately damaged and broken is particularly important, as this can shape the interpretation of the material. Of course, the method of fragmentation is not necessarily linked with the reasons behind deposition. However, by moving away from the traditional interpretations of isolated broken finds as lost waste from the metalworking process and instead establishing that they may be the result of deliberate destruction, it is possible to contribute to the object biography (Gosden & Marshall 1999) and develop a more nuanced understanding of the final actions undertaken on the objects. This approach has already been undertaken for isolated objects that have been more obviously destroyed to engage with the social ontology surrounding the object prior to deposition, such as the Bronze Age sword from Werkhoven, Netherlands (Fontijn *et al*. 2012, 207), or the Iron Age sword from Kirkburn, Yorkshire (Gosden 2008, 2006). The experiments confirm that the St Erth sword and Bloody Pool spearheads were heated and broken prior to deposition. Therefore, specific events must have occurred, including the construction of a fire and the fragmentation event itself, perhaps with the intention of subsequent deposition. Appreciating these processes can help us understand the individuals that may have been involved in them and the potential reasons for their destructive actions.

An important aspect of the results is that the deliberate destruction of Bronze Age metalwork was most easily undertaken using fire, though this did not necessarily leave any macroscopic signs of burning. Therefore, whilst some deliberately destroyed Bronze Age implements have obvious indicators of burning, such as those from the Duddingston Loch assemblage, Edinburgh, many broken objects may not. Fire has been recognised as part of the fragmentation process for Bronze Age metalwork (Turner 2010a, 99f.), but the experiments offer an insight into the temperatures and techniques required. Previously, the link between fire and fragmentation has been used to emphasise the involvement of a metalworker in the process as someone who would have had the skills and means to perform the task (Hoffman 1999; Nebelsick 2000; Melheim & Horn 2014). However, this concept requires reconsideration in light of the experiments.

Firstly, the experiments indicate that 500–600°C is an effective fragmentation temperature range for leaded tin-bronze objects, though Hardman's (2016) experiments illustrated that heat as low as 100°C could aid the breakage of tin-bronze bars. These temperatures can be compared with the temperatures required to melt and cast leaded tin-bronze: around 1000°C (Scott 2012, 243). From this, one can begin to understand the nature of the fire that would have been required. Fire and, by extension, the construction of a fire would have been an important part of Bronze Age life, required for cooking, warmth, and cremating the dead, as well as for craft activities such as ceramic production and metalworking. Experiments reconstructing prehistoric cremation pyres have managed temperatures of over 1000°C with no specialist equipment such as bellows or tuyères required (Marshall 2011, 14–5, 25–6; Dodwell 2012; Snoeck & Schulting 2013). It thus becomes clear that a metal-casting set-up would not be required to break bronze if the fire was constructed properly, and a metalworker would not necessarily be essential for the destruction event, only an individual with good knowledge of constructing a fire.

However, one must also assess other skills inherent to the destruction process. Whilst fragmentation *could* be achieved without any prior metalworking skill or knowledge – indeed I am not a trained metalworker

– it became clear during the destruction experiments that familiarity with the tools and materials would have been advantageous. Mr Burridge's experience of nearly two decades was essential in advising how to handle the tools, when objects should be removed from the fire, and where they should be struck for optimal chance of fragmentation. Moreover, Mr Burridge could predict how objects would likely react to the destruction methods implemented based on his knowledge of bronze as a material. Similarly, the metalcasting team at the Montale Terramare archaeological park judged appropriate temperatures for fragmentation based on the colour of the metal in the fire, without the use of a temperature probe. These aspects highlight an experiential element of the process that requires a familiarity with, and knowledge of, the metal one is trying to break. One may not need a metalworking fire and set-up, but the involvement of an individual with a working knowledge of the material, tools, and processes are beneficial.

The point of this discussion is not to confirm or dismiss the idea that a metalworker would or would not be involved in the destruction of Bronze Age metalwork, but rather to illustrate that by appreciating the associated processes, one can approach this question more objectively. By recognising efficient and effective fragmentation, it is possible to suggest the skills and knowledge of the individual conducting the destruction, and also gauge the intentionality behind fragmentation in the first place. The fragmentation of objects was clearly not a difficult task and was likely done with a certain outcome in mind.

It is here that the implications of these experiments can really be explored. Wiseman (2018) recently argued that the fragmentation and accumulation of objects in many metalwork hoards was the result of random activity and was undertaken for utilitarian purposes and as temporary stores to later be recovered. As Wiseman notes, this is at odds with other contemporary theories of fragmenting and depositing objects which focus on the selectivity of the practice (eg, Chapman 2000; Fontijn 2002). I would argue that the intended purpose of the fragments, be they sacrificial or functional, dictated how the objects were broken, and understanding the process of fragmentation can bridge the gap between these two purposes. If a sword was intended for recycling (a functional purpose), for instance, it may have been broken randomly into small pieces, which would be the result of heating and striking the sword without precision (the process); the resulting size of each individual piece would not have mattered provided it was small enough to fit into a crucible. The same can be suggested for socketed axeheads and ingots. Indeed, the need to understand how these objects might be broken is emphasised by Wiseman's (2018, 43) claim that 'axes are . . . , by their nature, difficult to break', a point which has been disproved by experiments fragmenting socketed axeheads (Knight 2019). Meanwhile, if an object required fragmentation in order to make it suitable for deposition in a ceremonial sphere, the breakage may indeed be random, provided the outcome was that the object was decommissioned. This explanation accounts for the breakage of the Bloody Pool spearheads, for instance, which were clearly never intended for recycling or retrieval. Overall, however, we should remember that the fragmentation event involved preparation and a degree of skill, the consumption of resources, such as charcoal, and the accumulation and deposition of objects was undertaken with intent situated within a specific social context.

Naturally, the destruction practice is just one element of a wider process. The discussion so far has largely divorced the actions from the depositional context from which deliberately broken finds are recovered, which can also inform the reasons behind deliberate destruction. The St Erth sword and the Bloody Pool spearheads may have been broken by the same method (ie heating and striking), but the St Erth sword fragments were deposited on a hilltop in a hoard containing a fragment of another sword, two incomplete axeheads, a socketed gouge, ingots, and metalworking waste. The Bloody Pool spearheads were deposited in a bog alongside spear ferrules. A traditional interpretation for fragmentary hoards, such as that from the St Erth hoard, is that it is the accumulation of scrap or material intended for recycling (cf. Wiseman 2018), whilst the watery context of the Bloody Pool accords with the idea of weapon sacrifices that occur during the Wilburton-Blackmoor phase of the Late Bronze Age (Mörtz 2018). The contexts were clearly governed by different social motivations, but in both cases it was necessary that the objects be broken before they were buried. This indicates a wider knowledge of how some objects should be treated to make them suitable for deposition and the best method for doing this.

Finally, the destruction experiments also demonstrated that breakage could be accomplished without the application of heat, and some of the archaeological parallels indicated that different methods were used for breaking and deforming objects, even within the same hoard. The fragmentation of a spearhead in the Stogursey hoard was potentially unheated, though other objects in that hoard show signs of heated fragmentation (Knight 2018, 382 ff.). Similarly, in her analysis of Late Bronze Age hoards from Essex and Kent, Turner (2010b, 30) suggests that the knives in the Grays Thurrock I hoard were 'bent and snapped by hand' unheated, though some of the fragmentation of swords and axeheads in this hoard could only have been caused through heated breakage processes. The mixture of heated and unheated damage suggests that the objects were damaged at various times with differential access to skills or resources, but were steadily accumulated over a longer period of time. This accords with Wiseman's (2018) model of many Late Bronze Age hoards as temporary stores to which objects were added or from which they were removed over time. Furthermore, by recognising that the bending of the Duddingston Loch sword may have been performed before the sword was then burnt adds a layer of complexity to the depositional practice. It indicates it was not merely sufficient to burn and break the objects, but that some had to be decommissioned by plastic deformation before this. A similar argument could be made for the notched and broken spearheads in the Blackmoor hoard. Accumulated different practices could ultimately relate to different social circumstances or variable access to resources or skills, or alternatively that a certain destructive practice was required for that specific situation.

CONCLUSIONS AND FUTURE DIRECTIONS

This paper offers a starting point for exploring destruction through experimentation, presenting a rudimentary reference collection for comparison with archaeological swords and spearheads, and complementing other experiments conducted on socketed axeheads (Knight 2019). However, there are multiple future directions that should follow.

Significantly, further destruction experiments exploring variables such as temperature and metallurgical compositions, as well as other forms of objects, are needed to refine the referential collection and better understand the nature of destruction in the past. Heating objects to over 500°C offers a stark contrast with unheated objects, but Hardman's (2016) experiments have demonstrated that incremental increases in temperature can produce different results when breaking objects. Developing avenues such as this would enable a more precise identification of deliberately destroyed objects, as well as contributing to an object's biography. Much research has been conducted on the production and use of objects, but comparatively little has yet been proposed for interpreting the final actions undertaken on an object, despite these often being the most observable archaeologically.

Additionally, a set of experiments conducted under laboratory conditions designed to measure the forces necessary to damage bronze objects, as well as monitoring the hardness of the metal when broken would be informative. A closer investigation of the effect of composition on breakage patterns would be similarly valuable. Metallographic analysis could be conducted to observe changes in the microstructure before and after destruction. It is a clear limitation of the actualistic experiments presented above that such analyses were not undertaken. Recording hardness values and the microstructural formation of the metal would feed into the reference collection and allow another avenue for identifying and comparing deliberate destruction on prehistoric artefacts.

Overall, this paper has demonstrated the benefits of approaching the deliberate destruction of Bronze Age metalwork from a practical perspective of understanding how it was achieved, rather than simply considering why. Through experimentation, there is the potential for better identifying and understanding the process of damage and destruction in the past. This involves not only undertaking methods of deliberate destruction, but also recording use-related damage. From this one can develop more informed ideas about the individuals involved, the knowledge and skills required, and the reasons why these actions were undertaken in prehistory.

NOTE

1. This follows a search of the Portable Antiquities Scheme online database (www.finds.org.uk) conducted on 02/06/2018 using the combined search terms 'Bronze Age', 'copper alloy', and 'swords'.

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RÉSUMÉ

Tomber en morceaux: investigation de la destruction délibérée d'épées et de pointes de lance de l'âge du bronze tardif, de Matthew G. Knight

La destruction délibérée d'épées et de pointes de lance de l'âge du bronze tardif a été largement reconnue à travers l'Europe. Typiquement,cette observation reposait sur la nature évidente de la destruction, telle que des lames tordues et des manchons écrasés et l'association avec de multiples morceaux brisés. Ces actes évidents ont été utilisés pour interpréter le matériel en termes de sacré et de profane sans avoir prêté l'attention qui lui était due à la manière dont le matériel avait été détruit. Cet article présente des recherches expérimentales qui explorent comment des épées et des pointes de lance ont pu être délibérément endommagées à l'âge du bronze. Nous comparons les résultats de ces expériences avec des artifacts de l'ensemble la Grande-Bretagne ce qui permet de mieux identifier et analyser les artifacts détruits délibérément. Nous présentons une série d'implications pour comment on pourrait interpréter plus précisément l'ensemble plus étendu des vestiges archéologiques

ZUSSAMENFASSUNG

In die Brüche gehen: Die Untersuchung absichtlicher Zerstörungen spätbronzezeitlicher Schwerter und Speerspitzen, von Matthew G. Knight

Die absichtliche Zerstörung von Schwertern und Speerspitzen in der Spätbronzezeit ist in ganz Europa bekannt. Diese Beobachtung beruht üblicherweise auf offensichtlichen Spuren der Zerstörung, zum Beispiel dem Biegen von Klingen oder dem Zerschlagen von Tüllen, aber auch der Vergesellschaftung mehrerer zerbrochener Stücke. Mit Hilfe dieser offensichtlichen Handlungen wurden die Funde als sakral oder profan interpretiert, jedoch ohne angemessene Überlegungen darüber, wie die Gegenstände tatsächlich zerstört wurden. In diesem Beitrag werden experimentelle Untersuchungen vorgestellt, in denen erforscht wurde, wie Schwerter und Speerspitzen in der Bronzezeit absichtlich beschädigt worden sein können. Die Ergebnisse dieser Experimente werden mit Artefakten aus ganz Großbritannien verglichen, was eine bessere Identifikation und Analyse absichtlich zerstörter Artefakte ermöglicht. Darüber hinaus wird eine Reihe von Schlussfolgerungen gezogen, wie der weitere archäologische Kontext exakter interpretiert werden kann.

RESUMEN

Going to Pieces: investigando la destrucción deliberada de espadas y puntas de lanza de la Edad del Bronce Final, por Matthew G. Knight

La destrucción deliberada de espadas y puntas de lanza de la Edad del Bronce ha sido ampliamente documentada en toda Europa. Esta observación se ha basado obviamente en la caracterización de la destrucción, como la acción de curvar los cuchillos o el aplastamiento de la zona de agarre, así como su asociación con múltiples piezas rotas. Estas acciones se han empleado para interpretar el material en términos sagrados o profanos sin la debida consideración de cómo se produjo la destrucción del material. Este artículo presenta un protocolo de investigación experimental en el que se explora cómo las espadas y las puntas de lanza podrían haber sido dañadas deliberadamente durante la Edad de Bronce. Los resultados de estos experimentos se comparan con artefactos procedentes de Gran Bretaña, haciendo posible identificar y analizar mejor los artefactos destruidos deliberadamente. Se presenta toda una serie de implicaciones sobre cómo se puede interpretar con mayor precisión un registro arqueológico más amplio.