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Striking a difference? The effect of knapping techniques on blade attributes

Hege Damlien

Museum of Archaeology, University of Stavanger, 4036 Stavanger, Norway

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ABSTRACT

Studies of lithic blade technology offer an important step towards explanations of technological diversification among Stone Age hunter-gatherers, and for tracking continuity and change in cultural traits through time and space. One prominent example is the many efforts to map the spatiotemporal diffusion of pressure blade technology. In this context, a key concern is to distinguish the various knapping techniques, applied by prehistoric knappers. Specific observable blade attributes, found by experimental work is proposed to provide essential information, to determine the technique used. To date, however, the causal relationship between blade knapping techniques and postulated technique-related attributes remains largely untested in quantitative terms. With the purpose of contributing to a better understanding of how various knapping techniques, and in this case the indentor type used for blade removal, effect particular aspects of blade morphology, statistical analysis of experimental data is used, and subsequently applied as a basis for predicting knapping techniques in blade assemblages from Early and Middle Mesolithic (ca. 9500–6300 cal. BC) Southern Norway. The results clearly indicate a considerable overlap in the distributions of the majority of the attributes with regards to technique, and that their causal relationship should be viewed with considerable caution. The discriminate capability increases, however, when specific composite attributes are considered. Importantly, what is also shown is that at the blade population level, results from statistical analysis of experimental data contribute to predict general tendencies in knapping technique variability in archaeological blade assemblages, while simultaneously formalising the discriminating characteristics that differentiate those assemblages. Taken together, these results have implications when investigating variation and change in blade technology in time and space.

1. Introduction

When approaching technological diversification among Stone Age hunter-gatherers, there is one recurrent question: By what means, and at what pace did cultural traits change through time? Blades were the principal blanks used for lithic tool production over large parts of Late Palaeolithic and Mesolithic Northern Europe. Variability in blade technology indicates, however, that Stone Age hunter-gatherers were not tied to one production strategy, but could potentially choose between a variety of core reduction methods and knapping techniques (Hertell and Tallavaara, 2011).

In Scandinavia, a prominent shift is demonstrated in the organisation of lithic technology during the time period from c. 8500 to 7500 cal. BC, with the introduction of blade production by pressure technique (Bjerck, 1986; Damlien, 2014; Damlien et al., in press; Knutsson and Knutsson, 2012; Rankama and Kankaanpää, 2011; Sørensen, 2012b; Sørensen et al., 2013; Tallavaara et al., 2014). The introduction of this technology into Scandinavia has been suggested to represent the first migration of people and/or diffusion of technological knowledge from the Eastern Baltic and Northwestern Russian plains (Damlien, 2014; Desrosiers, 2012; Rankama and Kankaanpää, 2011; Sørensen, 2012b; Sørensen et al., 2013), rather than a result of functional factors, such as mobility strategies or the raw material properties in the region (Andrefsky, 1994; Manninen and Knutsson, 2014). The specific timing and nature of this profound change in different parts of Scandinavia, however, remain largely unclear. In this context, an important step toward the explanation of lithic blade assemblage variability, and tracking the diffusion of technical innovations through time and space, is to understand the knapping techniques used by prehistoric knappers (e.g. Magnani et al., 2014).

E-mail address: hege.damlien@uis.no.

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Previous research has focused on a number of independent variables controlled by the knapper that affect flake morphology (e.g. Darmark and Apel, 2008; Dibble and Whitaker, 1981; Dibble and Rezek, 2009; Högberg, 2009; Magnani et al., 2014; Pelcin, 1997a, 1997b, 1997c; Schindler and Koch, 2012). Results from these studies demonstrate that the correlations between particular flake morphologies and various independent variables is the result of a complex process of various force application variables. Traditionally, identification of blade knapping techniques is based on specific morphological characteristics and technical signatures found by experimental work and, by analogy, recognised in prehistoric lithic assemblages (Inizan et al., 1999; Pelegrin, 1990, 2012; Schild, 1980; Sørensen, 2006b, 2008, 2012a). Few attempts have been made to formalise these observations. The causal relationship between various knapping techniques and the postulated technique-related attributes remain largely untested in quantitative terms. Consequently, it is important to develop better understanding on how various types of indentor tools and percussion techniques affects particular aspects of blade morphology.

Here I use statistical analysis of experimental data to examine the causal relationship between blade removal by direct percussion, indirect percussion and pressure techniques, and seven postulated technique related-attributes; interior platform angle, blade regularity, lip formation, bulb morphology, bulbar scar, conus formation and butt morphology. In addition, the composite of blade attributes containing the most predictive information are formalised, and subsequently used as a basis to predict knapping technique in blade assemblages from 20 Early Mesolithic (9500–8300 cal. BC) and Middle Mesolithic (8300-6300 cal. BC) sites in Southern Norway. Finally, the implications of these results are discussed in relation to questions concerning the timing and nature of the diffusion of pressure blade technique in Scandinavia, and the profound changes in lithic technology towards the Middle Mesolithic transition.

2. Assessing blade knapping techniques

In lithic analysis, an important distinction is between the production method and knapping technique (Inizan et al., 1999:30). Production methods refers to the intentional sequence of interrelated actions followed by the knapper to obtain the blades, whereas knapping technique is defined as the execution modalities, including the force applied, the morphology of the indentor tool, and the gesture and body position of the knapper (Inizan et al., 1999; Madsen, 1986; Pelegrin, 2006; Sørensen, 2012a; Tixier, 1967).

Production methods and techniques must be deduced from the archaeological record through very different procedures. While recognition of the method depends on refitting or technological reading of debitage products and situating each artefact within the operational production chain, identification of knapping techniques is based on specific attributes found by experimental work and, by analogy, recognised in prehistoric lithic assemblages (Pelegrin, 2006:39). A basic premise is that most changes undergone by a lithic artefact during its various life stages are recognisable on the object as several discrete attributes (Schild, 1980:57).

Previous research (e.g. Dibble and Whittaker, 1981; Högberg, 2009:72; Inizan et al., 1999; Madsen, 1986, 1992; Pelcin, 1997a; Pelegrin, 2006; Schindler and Koch, 2012; Sørensen, 2006b) postulates that different knapping techniques results in specific observable morphological characteristics and technical signatures, created in the process between application of physical forces and raw material fracture mechanics. The technique used can be inferred from technical signatures such as the character of the butt determined by the platform preparation (dimensions, aspect, edge angle) and discrete details determined by the detachment itself (cracks, lip, ripple on the bulb, aspect of the bulb), in addition to morphological characteristics such as the level of regularity, curvature and thickness of the blade (Pelegrin, 2006:42). The knapping technique is considered dependent on a variety of physical factors, influenced by the raw material (Sørensen, 2012a:27). The most relevant distinction is that between the detachment with a none-elastic (hard) hammer and detachment with an elastic (soft) hammer. The essential difference is that hard detachment must be considered a process characterized by *enfoncement* (rupture) at the point of impact creating a conchoidal fracture, whereas soft detachment is characterized by *arrachement* (tension) at the platform surface, resulting in bending fracture (e.g. Madsen, 1986:14).

The central knapping techniques involved in Scandinavian Mesolithic blade production can be organised into three categories. The first is blade removals by direct percussion technique, striking the raw material directly with various types of indentor tools. Direct percussion with a hard or medium hard stone hammer, involves striking the raw material directly with a stone of quartz or granite, whereas direct percussion with a soft hammer stone includes a stone of sandstone, chalkstone or cornstone. Direct soft percussion with an organic hammer includes a direct blow with a billet of antler, tooth or hard wood (Inizan et al., 1999:30–31; Sørensen, 2006b:23). The second is indirect percussion, which involves the application of an intermediary tool, called punch, which can be of wood, antler or bone, between the raw material and impact of the hammer. The third and final is pressure technique, involving the application of pressure to fracture raw materials. Pressure is applied with the narrow end of a tool made from wood or antler (Inizan et al., 1999:30–31; Pelegrin, 2006:40–41).

Diagnostic characteristics for different knapping techniques are defined through experimental work by numerous archaeologists studying the relation between technique and lithic materials fracture mechanics. The nomenclature of lithic technology and lithic attributes used here is defined, in particular, in the works of Jacques Tixier (1963, 1967), Francois Bordes (1969) and Don E. Crabtree (Bordes and Crabtree, 1969), and Marie-Louise Inizan, Hélène Roche, Michèle Reduron-Ballinger (1999), Jacques Pelegrin (1991, 2000, 2006, 2012), Bo Madsen (1986, 1992, 1996) and Mikkel Sørensen (2006a, 2006b, 2013a). Main results from these works concerning diagnostic characteristics of the central knapping techniques are summarised in Table 1.

Traditionally, blade attributes and their morphology, have been analysed by means of attribute classification (e.g. Andrefsky, 2005), a method also applied in this study. The classification method used here, is an established standard for technological studies for lithic and experimental archaeological research in Scandinavia, by convention referred to as dynamical technological classification. This methodology, derived from Romuald Schilds's (1980) work, and later developed by Mikkel Sørensen (2006a, 2006b, 2008) and the Nordic Blade Technology Network (http://www.nordicbladetechnologynetwork.se), in order to document and analyse not only knapping techniques but also the production methods and cognitive concepts of blade production, has its methodological basis in the French *chaîne opératoire* approach (Leroi-Gouhran, 1993 [1964]). The method concerns the classification of particular observable attribute morphologies and technical features.

A major critique against attribute classification is however that attribute morphologies often are viewed a priori as an indication of a specific technique, without this being questioned or tested (e.g. Darmark and Apel, 2008; Högberg, 2009; Shott, 1994). Several researchers have emphasised the need to formalise descriptive observations when dealing with archaeological experimental approaches (e.g. Darmark and Apel, 2008; Magnani et al., 2014). In this study, the purpose is to formalise an experimental basis for