Transmission of Tool-making through Verbal and Non-verbal Communication: Preliminary Experiments in Levallois Flake Production

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Abstract We describe a series of preliminary experiments undertaken to investigate the relationship between complicated tool-making and the presence or absence of language in its communicative role. The experiments involved teaching two groups of university students how to make Levallois flakes by either verbal or non-verbal demonstration. The rates and mean times of acquisition of the Levallois technique and of successful flake production were compared. They did not differ significantly between the two groups. From these results, we infer that spoken language was not indispensable for Levallois flake production in the Middle Palaeolithic.

Key Words: replicative experiments, Levallois flake, verbal demonstration, non-verbal demonstration

INTRODUCTION

Many anthropologists and Palaeolithic researchers are interested in the processes by which language first appeared in human prehistory. Evidence for the emergence of language is sought in various traces, physical and cultural, left by our ancestors, i.e. cranial endocasts, basicranial anatomy, stone tools, art, and indications of complex socio-economic organization that could not have been maintained without language.

Toth and Schick (1993) proposed experimental research as a promising means of obtaining information on the relationship between tool-making and the origin of language, particularly stressing the importance of replicative experiments in which modern people are taught tool-making in verbal and non-verbal contexts. They suggested that acquisition of tool-making skills be compared under two conditions: 1) detailed explanation of ways and strategies of tool-making by a competent flintknapper using verbal instruction plus visual demonstration and 2) non-verbal, only visual, instruction by the same flintknapper (Toth and Schick, 1993, p. 357).

It may be true, as Toth and Schick stated (1993, p. 357), that the learning pattern in pre-anatomically modern and pre-behaviorally modern hominids was quite different
from our own (see also, Klein, 1995), but it also may be true that replicative experiments such as those proposed by these authors will contribute useful information as to how language emerged in human prehistory.

In view of the possibility that spoken language first appeared among our ancestors in connection with the necessity to facilitate communication in their daily subsistence (e.g., Aoki and Feldman, 1989), we were interested in the relationship between complicated tool-making that apparently requires precise transmission of its production scheme and the presence of spoken language. In particular, we were interested whether or not the “Levallois technique,” known as a tool-making carried out with complicated procedure in mind, relied on language to convey the various subtleties in its implementation.

It is well known that this method for producing flakes, blades, and points was especially popular in the Middle Palaeolithic of Europe, West Asia, and North Africa. These artifacts are known as the Mousterian and generally regarded to have been left by *Homo sapiens neanderthalensis*. Levallois flakes excluding points, however, had appeared earlier in the Lower Palaeolithic industries in Europe and Africa known as the Acheulean (Breuil and Kelley, 1956; Leakey, 1955), meaning that the European and African *Homo erectus* at least had known this flaking method.

In 1961, Bordes described Levallois flaking methods, defining flakes with shapes predetermined on cores to be Levallois (Bordes, 1961, p. 14), and categorized them into three types: Levallois flakes with parallel or centripetal dorsal scars, Levallois blades or elongated Levallois flakes with length at least twice the width, and Levallois points detached from special cores that are distinct from those used for Levallois flakes and blades (pp. 17–18). Later, Bordes (1980, p. 45) called the Levallois flakes and blades with centripetal dorsal scars classical Levallois (*type classique*). This definition seems to have led many Palaeolithic researchers to regard the scheme of the Levallois flake production to be so complicated that it could not be realized without highly developed cognitive and communicative capacities.

Presently, Boëda explains Levallois in terms of its concept, method, and technique (Boëda, 1988a, 1988b). The Levallois concept, or the concept of Levallois predetermination, is unifacial débitage in which only one core surface is reduced for débitage, while the other surface is prepared for striking platforms. In this view, Levallois flakes are detached parallel to the intersectional plane of the two surfaces and the quantity of débitage is determined by solid content between the débitage surface and the intersectional plane. The Levallois method is divided by Boëda into two categories, both of which are demonstrated through his experimentation. One of them is called the *méthode linéale*, in which a singular Levallois flake, point, or pointed long flake is detached. Another category is called the *méthode récurrente*, in which multiple Levallois flakes, blades, or points are detached in a series. The technique comprises the action adopted in the methods and flaking implements used, namely hard hammer...
direct percussion.

With healthy modern humans as experimental subjects, we cannot address the question of whether language in its cognitive role is important. However, we undertook an experimental research to teach modern people how to make Levallois flakes, with and without instruction by spoken language, considering that the research would yield useful information on the relationship between complicated tool-making and the presence or absence of spoken language in its communicative role.

The results obtained from our replicative experiments are only preliminary, suffering from flaws in design, but we believe that they are of sufficient interest to report.

**METHODS**

From 11th to 14th of August 1995, replicative experiments were undertaken at two riverbanks (Saranuma and Takaseyama) along the river Mogami in the city of Sagae, Yamagata prefecture, Japan. Subjects of the experiments conducted by the present authors were students most of whom were majoring in physical anthropology at the University of Tokyo. All instructive demonstrations in both experiments were given by Ohnuma.

The students were separated into two groups of ten. The first group consisted mostly of senior students who had studied about the Palaeolithic in class and as such had general knowledge of lithic technologies, and the second group consisted mostly of junior students who had received no formal instruction. Randomization was not attempted because of problems of scheduling.

Raw materials used for replicative experiments were blocks of siliceous shale that were distributed on the two riverbank surfaces and were collected before and during the experiments. These blocks varied in colour from light- to dark-brown, and were generally of a fine grain. River pebbles of various materials were picked up from the riverbank surfaces, and those which were hard enough were used as hammerstones.

The replicative experiments in verbal communication were conducted at Saranuma on August 11th and 12th with the first group (mostly seniors) as subjects. Instructions were given in spoken language and by visual demonstration; hand-to-hand instruction was avoided (Fig. 1).

The procedure to produce Levallois flakes was demonstrated with hand-held, non-marginal direct percussion, following the method described by Bordes as the *type classique* (1980) and the identical one by Boëda, the *méthode linéale* (1988a; 1988b).

Thus, the demonstrator initiated technological instruction by determining the side and flaking surface of the core in accordance with the original shape of core blank. Then, the flaking surface was made smooth and slightly convex by continuous removal of surface preparation flakes, directed toward the center of the surface from the core side all around, which was more or less modified to be used as striking platforms. When the core surface became sufficiently smooth, one side of the core
was selected as the main striking platform for the final blow to detach a Levallois flake. This part was carefully shaped by delicate flaking called “faceting” in order to make its surface smooth and to make its angle against flaking surface around 80°. After this faceting was completed, the demonstrator detached as large a flake as possible from the core surface. Once the final blow detached a flake, demonstration was ceased whether or not the flake was satisfactory as Levallois. The direction and angle of percussion as well as suitable force of percussion in core shaping, faceting of striking platform and detachment of a final Levallois flake were demonstrated step by step in detail. The technological details particularly emphasized were: 1) impossibility of detaching flakes from striking platform that are more than 90° against flaking surface; 2) strong tendency of flake detachment extending along the straight line with percussion direction; and 3) midway stop of flake detachment in case flaking surface is not smooth with serious irregularity.

The replicative experiments consisted of three practice sessions, each lasting two hours including the demonstration, and a final test session also lasting two hours but without demonstration. During the practice session, the students were allowed to ask questions in spoken language, and the demonstrator answered their questions in spoken language and by gesture. When the students could not overcome a failed situation, they were allowed to change core blanks in order to start again from the beginning. In the final test session, however, they were not allowed to ask questions, and submitted their final products whenever they were satisfied with them.

The site of the replicative experiments in non-verbal communication during August 13th and 14th was shifted from Saranuma to the riverbank at Takaseyama, approximately 2 km apart along the river Mogami, for the reason that observable good
blocks of siliceous shale became scarce at Saranuma. The siliceous shale found at this newly selected riverbank at Takaseyama was considerably better in quality than that used at Saranuma. The experiments were undertaken with the second group (mostly) juniors by visual demonstration alone, again not using hand-to-hand instruction (Fig. 2).

The demonstrator explained to the students about the procedure of Levallois flake production (Fig. 3) and the technological details to be particularly noted, in the same order as at Saranuma but by gesture alone, i.e. how to use hammerstones and how to
control direction, angle and force of percussion, as well as impossibility to detach flakes from obtuse-angled striking platform, flake detachment extending along the percussion direction and midway stop of flake detachment on irregular flaking surface.

Due to the limitations of gestural communication, the demonstrator felt it far more difficult to instruct the students in the non-verbal group about the technological details as he intended, particularly about the ideal angle between striking platform and flaking surface and the necessity to make flaking surface smooth. It was also difficult to explain that the end objective was the finally detached flake rather than the totally reduced core.

As with the verbal group, the experiment totaled four sessions: three practice sessions, each lasting two hours including demonstration, and the final test with no demonstration also lasting two hours. The students were allowed to ask questions during the practice sessions by gesture alone, and the demonstrator answered the questions in kind. As in the earlier experiment, the students were allowed to change core blanks

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<th>Subject</th>
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The subjects in each group have been renumbered in ascending order of time required to acquire the Levallois technique. The subject was judged to have acquired the technique if he/she completed all steps in core preparation and understood that a final blow would produce a Levallois flake. One subject in the verbal group and two in the non-verbal were unable to acquire the technique within the duration of the experiment (480 minutes). In the case of four subjects in the verbal group and two in the non-verbal, technique acquisition and flake production coincided. See text for details.
to overcome failed situation, and in the final test session they submitted their final products without being allowed to ask any questions.

RESULTS

The subjects were evaluated at two levels of achievement by Ohnuma. He/she was judged to have acquired the Levallois technique if all steps in core preparation were completed and it was understood that a final blow would produce a Levallois flake. He/she was judged to have produced a Levallois flake if, in addition, the final blow resulted in successful detachment. By these criteria (see Table 1), nine of ten subjects in the verbal group and eight of ten subjects in the non-verbal group were able to grasp the Levallois technique within the duration of the experiment (480 minutes). Moreover, six subjects in each group were successful in Levallois flake production (Figs. 4 and 5), although one subject in each group detached an atypical flake. Hence, the rates of acquisition of the Levallois technique and production of a Levallois flake do not differ significantly between the verbal and non-verbal groups.

Quality such as symmetry and thickness of the flakes successfully produced in both groups is acceptable as Levallois, though of course far from being comparable to that of archaeological specimens. Insufficiency is particularly seen to the same degree in both groups in rough nature of "faceting" of the main striking platform.

The distributions of time elapsed until the technique was acquired and the distributions of the time elapsed until a flake was produced are given in Table 1 for the subsets of the subjects in each group that did so. Note that the four distributions are conditional on the event—acquisition of technique or production of flake—having
occurred. All four distributions fit the normal (Kolmogorov-Smirnov test, 5% level), which justifies the use of the F-test and t-test. These standard statistical methods are described in Sokal and Rohlf (1995). The variances of the time until acquisition of technique are not significantly different between the two groups (two-tailed F-test, 5% level). However, the variance of the time until production of flake is significantly greater in the verbal as opposed to the non-verbal group (two-tailed F-test, 5% level). Neither the means for the time until acquisition of technique nor that for time until production of flake differ between the groups (exact two-tailed t-test for former comparison at 5% level of significance, approximate t-test for latter since the variances are different).

CONCLUDING REMARKS

The following preliminary conclusions have been reached as a result of our replicative experiments. The conclusions, however, apply to the production of Levallois flakes, and may not be directly pertinent to other types of tool-making, such as hand-axe manufacture, Levallois point manufacture, and production of blades and bladelets by percussion or pressure flaking. It is also emphasized that the results could have been more or less different if we had undertaken experiments with children, not university students.

Before conducting the experiments, we had expected that use of spoken language would facilitate the transmission of the Levallois technique from the demonstrator to the subjects. The verbal group enjoyed another advantage in that it comprised mostly seniors who had learned about lithic technologies in class. However, there were no significant differences between the two groups either in the rates or mean times of acquisition of the Levallois technique. Similarly, the verbal and non-verbal groups
showed no significant differences in either the rates or mean times of successful flake production. One factor perhaps contributing to the low performance, relatively speaking, of the verbal group was the quality of raw material. The siliceous shale at Saranuma was considerably coarser in grain than at Takaseyama.

It is surprising that visual demonstration alone was so effective in transmitting the Levallois technique, especially in view of Washburn’s report of Desmond Clark’s work (Washburn, 1969). Because Stone Age people, young or adult, daily observed how Levallois flakes were made and used, there was more opportunity for them to learn, even if they did not possess spoken language, than the students in the non-verbal experiments. One student in the non-verbal group misunderstood throughout the experiment about the purpose of detachment of a final Levallois flake, considering it as the operation aimed to thin basal part of a tool. This interestingly reminded us that Levallois flakes first appeared in the European and African Acheulean in strong association with technology of hand-axe manufacture, especially with probable thinning of hand-axes to remove thick portions (see for example, Caton-Thompson, 1952, Pl. 48–3). Observation of end use would help to remove such misunderstanding.

From the research results we obtained, we suggest that spoken language was not indispensable for Levallois flake production in Stone Age, and that this unique tool-making method belonged to a different level of subsistence activity from that which necessitated language. At the very least we can say that the quality of raw material may have been a more important factor in Levallois flake production than the presence or absence of spoken language. We emphasize the preliminary nature of our research, and welcome criticism and parallel experiments by other researchers.

ACKNOWLEDGEMENTS

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