

THE “PROTECTIVE GESTURE” PROTECTS FROM WHAT?

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1. *Introduction**

The themes represented on the walls of tomb chapels are not only these closely connected with the mortuary cult but also themes depicting activities based on various aspects of daily life. Over the years many studies of these decoration themes have been made, featuring various aspects from various points of view.¹ Most of these studies divide the larger scene into sub-themes, and interpret each one of them separately, at the end combining these interpretations in order to arrive at a conclusion as to “why” they were placed on the wall. Yet minor details of the various themes have never been thoroughly studied.² For many themes and sub-themes the problem remains that it is not certain whether they just convey a message, or show what is really happening,³ or want to show how a particular process works. The subject of this study, the raising of the hand to the head, is just a minor detail of larger scenes, which themselves are multi-functional in relation to the tomb owner and the visitor.

It is unavoidable that in the decoration themes details were introduced that the artist could have considered necessary to reinforce what he wanted to show,⁴ but that had no deeper sense with regard to the religious beliefs that mattered for the tomb owner, his afterlife and his cult. One of these details could be the sub-theme in which a person has a hand raised toward the head, a detail without demonstrable importance for the mortuary cult of the tomb owner.

This gesture is depicted in several decoration themes, and in some of them a source of heat plays a crucial role. Often, but not always, in these scenes the person taking care of the fire is depicted making a gesture that looks like an attempt to protect part of the body or at least the face, and which in Egyptological literature is nearly always interpreted as such,⁵ although some scholars have a slightly different opinion about the gesture.⁶

* I would like to thank Mr. David Sexton (literary critic, columnist “Evening Standard”, London) for going over my English; mistakes of any kind are entirely of my hand.

¹ Verma, *Cultural expression*, 6.

² An example of a later study that discusses a detail of one of the decoration themes can be seen in Brovarski, *False doors*. A study discussing the introduction of a gesture made by the tomb owner is Kanawati, in Ziegler (ed.), *L'art*, 281-310.

³ Van Walsem, *Iconography*, 71ff.

⁴ Verma, *Cultural expression*, 20 points out that the artist had some room to express personal insights, although within narrow boundaries. Drenkhahn proposes that these boundaries are based on the consideration that the group “craftsmen” can be divided into two main categories, those employed by a private person, and those employed by the state, but that they never worked on an individual (private enterprise) basis (Drenkhahn, *Handwerker*, 135-143, 156). Kanawati states that in spite of the seemingly repetitiveness of the scenes on the walls, the freedom of the craftsmen can be discerned in the details (Kanawati, *Tomb*, 74).

⁵ McFarlane and Mourad, *Behind the Scenes*, caption Pl. 26.

⁶ A scholar with a slightly different opinion is Montet who interprets the gesture as protection from the ashes and the smoke coming from the fire (Montet, *Scènes*, 236).

In ancient Egyptian culture many examples exist presenting this gesture, both in two-dimensional representations on the walls of the chapels and in three-dimensional representations found as statuettes (“servant statues”) in the serdab, and later in the burial chamber.⁷ An overview of the settings in which the raised hand is represented, shows that the number of different scenes is not large. Furthermore, it shows that the presence of a source of heat is not an absolute requirement, indicating that an interpretation of the gesture of the persons tending the fire as protective might be too obvious, and is possibly not the message that was intended to be conveyed by it. Study of the examples reveals that the gesture is made either in the presence of a source of heat, so that the temperature of the source appears to play a decisive role, or as a protection from the direct or reflected light of the sun in order to be able to see without being blinded.

In this study the “protective” gesture and the context in which it is used within the decoration theme (e.g. equipment, fuel, and surroundings) will be explored in order to see whether the explanation given in Egyptological literature is valid, or whether an explanation other than a protective gesture from heat can be proposed.

Closer study of this detail also allows a hypothesis to be formulated about the circumstances in daily life in which the raised hand was used.

2. *About this study*

As already mentioned, a person is depicted with a raised hand in several themes, including not only the scenes depicting various crafts with a source of heat, but also the pounding of sheet-metal,⁸ the weighing of ore or metal,⁹ sculpting and painting,¹⁰ a priest during one of the phases of the mortuary ritual,¹¹ and gestures made by members of the crew of a ship. The subject of this study is only concerned with the scenes in which the gesture seems to be made in order to avoid physical discomfort.

A closer study of the decoration themes that can be included shows that basically a division into three groups is possible:

1. Themes depicting a source of heat including the gesture.
2. Themes depicting a source of heat, but without the gesture.
3. Themes depicting the gesture without a source of heat.

Each of these groups will be discussed separately on the basis of one or more examples of the activity concerned.

⁷ Roth, *JARCE* 39, 117-118.

⁸ Swinton, in McFarlane and Mourad (eds.), *Behind the Scenes*, Fig. 4 (p. 172); Davies, *Deir el-Gebrâwi*, Pl. XIX.

⁹ Brovarski, in Der Manuelian and Simpson (eds.), *Gmast* 7, Fig. 116b.

¹⁰ Swinton, in McFarlane and Mourad (eds.), *Behind the Scenes*, Fig. 1 (p. 168).

¹¹ Der Manuelian, in Der Manuelian and Simpson (eds.), *Gmast* 8, Fig. 13.33; McFarlane and Mourad (eds.), *Behind the Scenes*, Fig. 2 (p. 19).

3. Themes with the source of heat depicted

The heating equipment employed was to a high degree dependent on and strongly adapted to the type of work that had to be done. A thorough description of the differences between the various types of equipment would require a profound investigation of their basic technical and pyrochemical properties which is beyond the scope of this study. Only technical data indispensable for understanding the direct impact they might have on the behaviour of the persons employing them will be discussed.

The activities using sources of heat are the following:

1. Manufacture of pottery or bread moulds in a kiln.
2. Pre-heating bread moulds.
3. Baking bread.
4. Roasting or boiling meat, fish or poultry.
5. (S)melting of ore or metal.

A closer study shows that there are several ways in which the gesture is depicted:

- The hand is raised in front of the head.¹²
- The hand is raised at the side of the head.¹³
- The head is turned away,¹⁴ while the hand can remain raised.¹⁵

3.1. The manufacture of pottery and bread moulds in a kiln

The kiln is a construction designed to reach temperatures that will change a dried clay model into a non-plastic structure. The sintering of the clay usually starts between 600 °C and 700 °C and if the temperature is not raised further the result is a porous piece of pottery; the moulds used for the baking of bread are an example of this.¹⁶

Baking the various types of bread moulds at a higher temperature would be a waste of fuel because the usable life of such a piece of pottery was short.

In the tomb of *Tjii* (PM III/2, 468-478) in the necropolis of Saqqara the process of production of bread moulds and beer jars in a kiln has been depicted on the western wall of the store room (the left side of the highest (7th) register in Fig. 1). The most common form of kiln, the updraft kiln, has a firing opening at the underside (an updraft kiln is a type of kiln where the fire is placed under the pottery and where the heat goes upward to the opening at the top).¹⁷

¹² In three-dimensional depictions a hand in front of the face would normally form an obstruction, while in two-dimensional representations the hand can be placed in front of the face and its profile will remain perfectly visible. Yet in the Alexandria National Museum in Egypt a damaged servant statue depicts a man undoubtedly sitting in front of a no longer present pile of bread moulds that are being heated while he has a hand partly in *front* of his head. The suggestion of a fire in front of the man is strengthened by the right hand having a hole indicating the presence of a now lost poker.

¹³ See *intra* Fig. 3.

¹⁴ *Ibidem*.

¹⁵ Simpson, *Gmast* 2, Fig. 38.

¹⁶ The crucibles used to melt metal were also made of clay that had been fired to a temperature between 600 °C and 700 °C during production (Davey, in Evans, *Ancient Memphis*, 85-107).

¹⁷ Nicholson, in Wendrich *et al.* (eds.), *UCLA Encyclopedia of Egyptology*, 60-65.

In the decoration on the wall in the tomb of *Tjj* it can be seen that the man is sitting in front of the opening of the kiln because he has a downward pointing poker in his hand. The same type of kiln has been depicted on the western wall of the main room in the tomb of *Hnmw-htp* [III] (PM IV, 149, tomb BH3) at Beni-Hasan.¹⁸ In this case it is visible that the air inlet is on the underside (in view of the type of activity it appears that the kiln is not fired).

Undoubtedly, after a longer period of firing the kiln would have started to radiate heat over the whole of its surface. This would expose the entire body of the person in front of it to increasing heat intensity, although the ambient temperature for the production of bread moulds would not be extremely high. As a result, the raising of the hand could be interpreted as a gesture protecting from heat, although the problem of the exposure of the rest of the body remains.

Since throughout Egypt (the Nile valley, the oases and the Sinai) for most of the year the prevailing wind is from a northerly direction (ranging between north/east and north/west),¹⁹ a logical conclusion is that the opening of the kiln would be angled in that direction in order to provide the maximum amount of oxygen for the fire within.²⁰ If this was indeed the case, the person tending the fire is facing south, while another consequence of this orientation of the opening and the prevailing wind is that the heat of the surface of the kiln is blown away from the person sitting in front of it. This would make it probable that the gesture is not primarily meant to protect the face or the eyes from the heat of the kiln.

3.2. The pre-heating of bread moulds

In the wall decoration given in Fig. 1 the pre-heating of bread moulds has been depicted three times (once in register five and twice in register two). The two bread mould heating scenes in register two depict the *bd3* mould, the type most frequently used during the Old Kingdom; in the scene in register five *stt* moulds are heated.

All three scenes of pre-heating moulds, cited above, show the person tending the fire positioned with one hand raised to the head. As previously indicated, the usual interpretation, based on the relatively elevated temperature of the fire, is that this person is protecting his/her face from its radiating heat.²¹ However, this interpretation is at least questionable, since no protection is deemed necessary for the rest of the body which is left almost completely unprotected. That the gesture is not necessarily protective can be deduced from the following:

- Judging from the depiction, the scene in Fig. 2 strongly suggests that the woman is probably *not* protecting her face from the heat of the fire, firstly because the hand is

¹⁸ Lepsius, *Denkmäler* II, 126.

¹⁹ The following information is obtained from websites giving the current predominant wind of the various locations. Delta and northern Nile valley: north-west; Sinai: north; Siwa: north to north-east; Farafra: north-west; Dakhla: north-east; Kharga: north-west; Baharia: north to north-west. The Old Kingdom decoration themes depicting ships in motion show that these wind directions have not changed over the course of time. For a further discussion of the prevailing winds and navigating the Nile, see: Graham, in Piquette and Love (eds.), *Current Research in Egyptology 2003*, 42-44.

²⁰ In the available literature concerning kilns neither depictions nor excavation reports offer the chance to determine the direction of their opening.

²¹ Kanawati and Abder-Raziq, *Teti Cemetery* V, 40; Junker, *Giza* XII, 120 also mentions sparks (why protect the face and eyes against sparks while the rest of the body is exposed to them?).

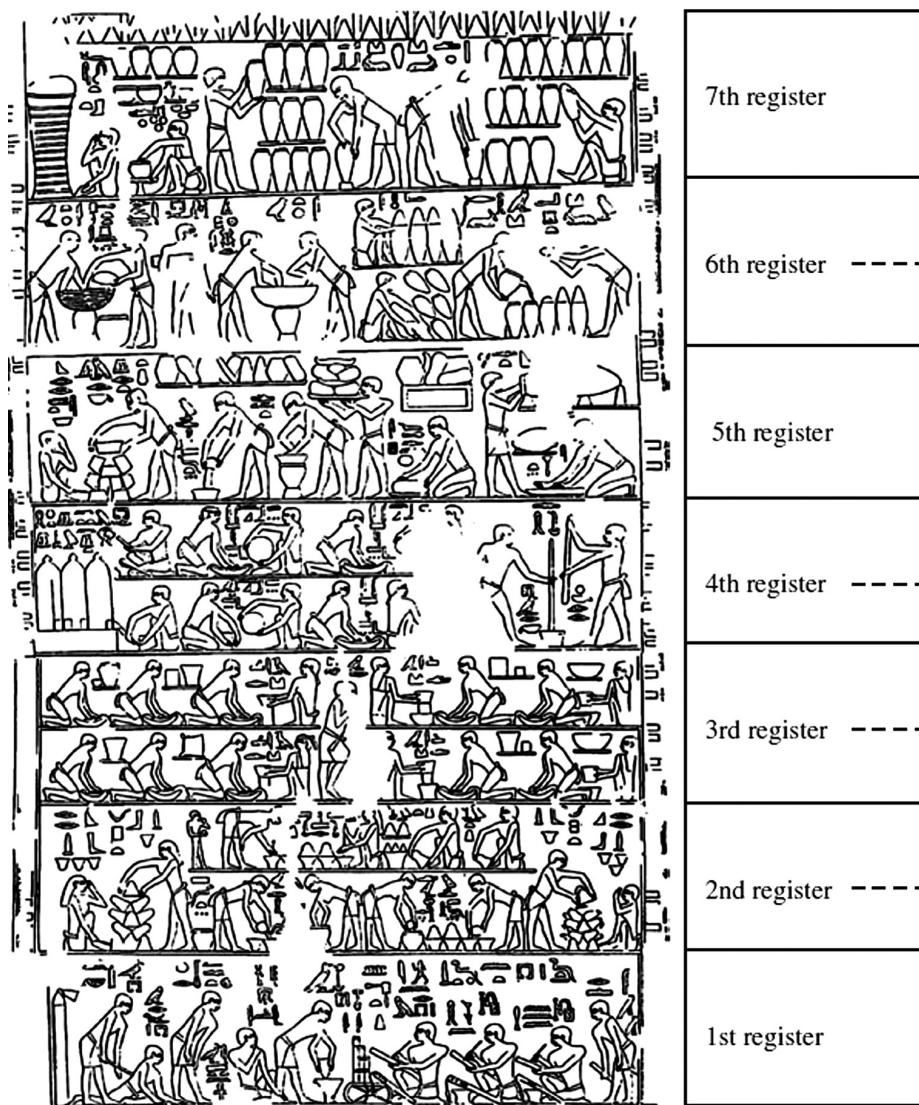


Fig. 1. The decoration of the western wall of the store room in the tomb of *Tjj* (PM III/2, 468-78; plan XLVIII, wall 32); Montet, *Scènes*, Pl. XX; Steindorff, *Ti*, Pls. 83-86.

held too high and secondly in reality she cannot be too close to the fire because the naked child is even closer to it than the upper part of her body.

- In the chapel of *Mr.s-ḥ* [III] (PM III/1, 197-199) a woman is depicted in front of a fire and she has her left hand against the side of her head.²² Statue MFA 21.2600 shows a woman sitting in front of a heap of *bdj* moulds in the process of being heated, and she is holding her hand at the left side of her head too.

²² Dunham and Simpson, *Gmast* 1, Fig. 11.

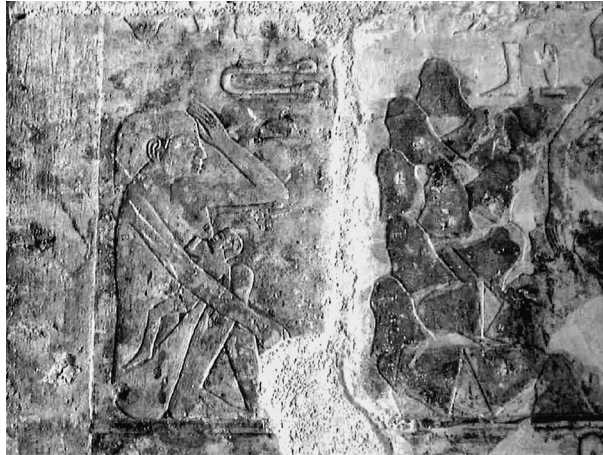


Fig. 2. Pre-heating *bd3* bread moulds (Tomb of *Nj-’nh-Hnmw* and *Hnmw-htp*: PM III/2, 641-644); www.osirisnet.net.²³

- It is evident that there is no distinction between the attitudes of men or women, because in the Roemer-Pelizaeus Museum at Hildesheim the statue with inventory no. 2140 shows a man sitting in front of a fire on which he is pre-heating *bd3* moulds and he holds his hand at the side of his head.²⁴
- Statue Cairo JE 72227 shows a woman sitting before a (now lost) fire; she is turning her head and her left hand is lying against her neck. Perhaps here the turning away of the head might be a sign of great heat,²⁵ but a more probable interpretation is that she is looking away from a strong light source (either the hearth or the sun).
- In the second register of the decoration of the storeroom in the tomb of *Tjj* at Saqqara (Fig. 1) two fires are depicted. On both fires *bd3* moulds are pre-heated. The woman at the left side of the register gives the impression that she has her hand beside her head, while the man on the right side has his hand clearly in front of his face.²⁶
- In a decoration in the chapel of *M.rs-’nh* [III] (PM III/1, 197-199) two scenes of pre-heating bread moulds are depicted; in one, the pre-heating of *bd3* moulds, the person tending the fire is holding her hand to the left side of her head; in the other, *’pr.t* moulds are heated and the man sitting next to it does not raise his hand toward his head, while he is saying “hasten ye, this is hot” to someone sitting behind him.²⁷ It should be noted that the *’pr.t* moulds are being heated on a brazier and not over an open fire, which will somewhat reduce the radiated heat.

²³ With the kind permission of Dr. Benderitter (webmaster www.osirisnet.net). In this presentation the height of the pile is above average (see Fig. 1).

²⁴ Junker, *Giza* VII, Plate XXIIc. Drenkhahn observes that women were involved only in selected areas of the various crafts, but that in these areas both men and women could do the work (Drenkhahn, *Handwerker*, 133-134).

²⁵ Hassan, *Giza* VI(3), 180, Pl. LXXVIII (Fig. 3); Reed, in Bárta (ed.), *Old Kingdom*, 151-152.

²⁶ The contrary lines of orientation of the two persons shown within one register indicates that the direction of depiction has no realistic value.

²⁷ Dunham and Simpson, *Gmast* 1, Fig. 11. The person sitting behind him is probably preparing dough for the moulds he has on the brazier.

- In the mastaba of *Htp-ḥr-ḥtj* (PM III/2, 593-595) *pr.t* and *bd3* moulds are pre-heated in the same pile.²⁸ The person tending the fire is looking down into the heart of the open fire, but the hand is placed high on the head, indicating that the purpose of the hand is protection from the glare of the sun in order to better see what is happening in the fire.

In all probability, the person tending the fire was not, in fact, as close to it as is suggested in the scene on the walls and in the models; after all, sticks that can be used as pokers come in many sizes. On the wall, the distance between the person and the fire had to be reduced in order to prevent the appearance of an open space in the decoration, and in a model the figures cannot be too far apart.

The gesture in front of the face might be explained by presuming that the fierce glow of the fire makes it necessary to physically protect the eyes, because these are the most sensitive part of the face. However, this presumption is countered by the following arguments:

1. Raising the hand in a way that diminishes the intensity of the glow of the fire would not improve vision, because squinting would be a better way.
2. It is evident that in most of these depictions the hand is raised too high to protect the eyes from the glow of the fire (Fig. 2), while the heat source used is always below the level of the head of the person tending it.

Protection from the fierce glow of the fire cannot be the explanation for the hand next to the head, or the hand that is raised too high. It is more plausible that the hand is raised to this position to shield the eyes from the sun. This would explain the various positions of the hand in relation to the head. The hand held high in front of the head would mean that the eyes are protected from the glare of the mid-day sun, whilst the hand beside the head indicates protection from the morning or evening sun.

These problems with direct sunlight arose because, due to the prevailing north wind driving the smoke and the heat southward, the person tending the fire would be sitting upwind and thus looking south. However, like the workshops for metal melting,²⁹ bakeries too were columned and roofed over construction, which appears to make this explanation less likely.³⁰ Looking at the models of walled-in bakeries and breweries that have been found in the tomb of *M'kt-R'* (PM I/1, 359-364; TT 280; date: XII.1) the conclusion is that all the phases connected to these crafts are depicted except the pre-heating activities.³¹ From these models it is evident that this is done somewhere else, or, more probably,³² at the extreme southern end of the bakery which itself is also placed at the southern, western or eastern side of the settlement.³³ At the southern end of the Plateau of Giza, in the 4th dynasty settlement south

²⁸ Wild, *BIFAO* 64, Pl. X.

²⁹ Ibidem, Fig. 5. Lotiform poles are used in the metal workshop depicted in Badawy, *Ankhhmahor*, Fig. 32 (Swinton, in McFarlane and Mourad (eds.), *Behind the Scenes*, Fig. 1 (p. 168)).

³⁰ Lehner *et al.*, *GPMP*, 2006-2007, 48.

³¹ For a model without enclosing walls and with a pre-heating scene, see Museo Egizio Turin, no. 13271 in Tooley, in Eyre and Leahy (eds.), *Unbroken Reed*, Pl. XLI.

³² Tavares, in Strudwick and Strudwick, *Old Kingdom*, 270-277.

³³ Lehner, in Lehner and Wetterstrom (eds.), *GPMP* I, Fig. 1.9 (p. 14). Three-dimensional models exist in which the pre-heating scene is shown next to the other stages of the baking of bread, but these models are not walled-in

of the wall “Heit el-Ghurub”, galleries have been built for the phyla that worked in shifts on the pyramid then under construction on the plateau.³⁴ Because the galleries were centrally provisioned, the central bakeries that were necessary for part of their sustenance were situated south and east of these galleries.³⁵ In the “houses” at the south end of the galleries themselves a (small) bakery was usually present, but this was for personal small scale production only.³⁶

This analysis would explain the gesture of the woman in servant statue JE 72227 (Fig. 3) where she is not only showing the hand gesture of protecting the eyes from the sunlight coming from the side, but she is also turning her head away, and it is not possible to decide whether this from the glare of the fire or the sun.

In three-dimensional representations two groups can be distinguished:

- In stone statuary the gesture of the hand placed at the side of the head might simply be due to the technical difficulty of representing in a stone sculpture an arm without support (Fig. 3), and the impossibility of placing the hand against the front of the face (in a stone servant statue in the Alexandria National Museum, the sculptor partly solved the problem by attaching the hand to the face but covering only its left side).
- In wooden statuary limbs can be fixed in positions that are impossible for stone statuary. Loose hanging arms could be attached to the torso by means of dowels. If the arms were not made as separate parts, they could be supported by a small part of the arm in connection with the body with or without negative space.³⁷ In the simpler wooden servant statues these solutions were not used, and in most of these statues the arms were just straight sticks connected with a pin to the body.³⁸

The gesture of a hand at the side of the head is frequently shown in stone statuettes (Pelizaeus Museum Hildesheim, 2140).

A possible explanation is that the gesture was only added to the scene to show that the person was sitting next to a burning fire of elevated temperature; although in reality there would have been no need to sit so close because a large poker could have been used.³⁹ However, not every depiction of this activity shows the person with the hand raised in this way,⁴⁰ indicating that the gesture was not a symbol or a message; it could be added, but that it was not of major importance.

and must be considered simply showing the various activities connected to the craft. This situation did not change in later periods either (Aufrière, *L’Égypte* 2, 60). In some models the pile of moulds was added, but without a person tending it (National Museums Scotland, A.1914.71).

³⁴ Lehner, in Lehner and Wetterstrom (eds.), *GPMP* I, 190 ff.

³⁵ Lehner *et al.*, *GPMP 2006-2007*, Figs. 17, 22; Tavares, in Strudwick and Strudwick (eds.), *Old Kingdom*, 271.

³⁶ Altogether these small-scale hearths must have given rise to a constant layer of smoke over the entire settlement.

³⁷ Harvey, *Wooden statues*, A66 for a connection between hand and body with negative space, and A83 without. An arm with a sharp bend in it could be made out of one piece of wood, albeit with a high risk of breaking (Harvey, A11), or it could be made out of two pieces (Harvey, A48, B16).

³⁸ Rosicrucian Egyptian Museum, San Jose, California EMS 89615; MFA, 21.823.

³⁹ The radiated heat was sometimes shown as rays or flames coming from the fire (*Nj-’nh-Hnmw* and *Hnmw-ḥtp; Nfr* and *K3-ḥ3.j* (intra Fig. 7)).

⁴⁰ Borchardt, *Statuen* I, no. 247 (JE 30818).



Fig. 3. Servant statue (JE 72227) from the tomb of *Nj-k3.w-Ḥt-Ḥr* (PM III/1, 247); from Hassan, *Gîza* VI(3), 180, Pl. LXXVIII.

In the tomb of *Ppj-ḥḥ-ḥrj-jb* (PM IV, 254-255) a scene that is part of the baking/brewing process shows a man sitting next to a pot that is standing on an object that looks like a standard, but might also be a brazier, so in this image it is not possible to determine with certainty whether a source of heat is involved.⁴¹

In Fig. 1, in the lower sub-register of the second register, a man is depicted with both arms in a similar pot with standard, and because both scenes are in the context of the baking of bread, it can be concluded that they are identical in meaning and that no heat is involved. This indicates that the gesture is added to show that the man stirring the contents of the pot is protecting his face from the sun.

3.3. The baking of bread⁴²

In the Old Kingdom several methods of baking bread can be identified:⁴³

1. Under the ashes of a fire.
2. On pre-heated stones.⁴⁴
3. In bread moulds.⁴⁵
4. Put on a stick and baked over an open fire or glowing charcoal, or directly placed on the latter.

⁴¹ Kanawati, *Tomb*, Fig. 122.

⁴² <http://www.aeraweb.org/lost-city-project/feeding-pyramid-workers/>.

⁴³ In the burial chamber of the tomb of *Gm-nj-m-Ḥt* (PM III/2, 538-539) a model of a combined brewery, bakery and a slaughterhouse has been found (Ny Carlsberg Glyptotek, AEIN, 1631). In the bakery a new (closed) form of oven can be seen. The person tending the fire does not show the protective gesture, but because this is a model, it is not certain whether or not in reality this oven was standing outside.

⁴⁴ Borchart, *Statuen I*, no. 238 (JE 30820) from the tomb of *Nj-ḥḥ-Ppj-km* at Meir (PM IV, 247).

⁴⁵ This method was mostly used in bigger settlements because it could produce a lot of loaves in a relatively short time; Lehner, in Lehner and Wetterstrom (eds.), *GPMP I*, Figs. 1.15 and 1.16 (p. 25).

In Fig. 1 the registers 2, 3 and 4 are dedicated to the production of bread loaves. In registers 3 and 4 the preliminary activities are depicted, while in register 2 the actual baking of the bread is shown. In register 2, this goes from the pre-heating of the moulds on both sides of the register to the subdivided middle section, showing the preparation of the dough before it is poured into the hot moulds, after which a (preheated) second mould is placed over it as a lid. In this sequence the heating of the filled moulds is not depicted,⁴⁶ although this would be consistent with the archaeological finds of thick layers of ashes in bakeries in the workmen's village in the southern part of the Giza Plateau.⁴⁷ This activity is followed by checking the bread has cooked before it is finally taken out of the mould.

Baking bread was not confined to a fixed place, because it could also be done in the open field, when an expedition stayed away for a longer time. In the field an open fire made of wood was more convenient because taking along charcoal, the fuel most used, would have been bulky (although light in weight).⁴⁸

In the chapel of *Nfr* and *K3-h3.j* (PM III/2, 639-641) a scene shows the baking of bread in the field over an open fire with the flames plainly visible (Fig. 4).⁴⁹ Apparently the temperature of such a fire is not too high because both men who are busy baking the bread are doing



Fig. 4. Baking bread over an open fire. Tomb of *Nfr* and *K3-h3.j* (PM III/2, 639-641; date V.M-V.L).

⁴⁶ Lehner, in Lehner and Wetterstrom (eds.), *GPMP* I, 25; M. Lehner, *Oriental Institute 1993-1994 Annual Report*, 26-30. What is shown frequently is a row of *bd3* moulds, some of which are being filled while the rest are closed with the second mould on top of them (Dunham and Simpson, *Gmast* 1, Fig. 11).

⁴⁷ Possibly this is not depicted because hot ashes might have been used instead of open fire.

⁴⁸ Moussa and Altenmüller, *Nefer*, Pl. 5.

⁴⁹ The same is visible in the scene of baking bread in the field depicted in the tomb of *Nj-'nh-Hnmw* (PM III/2, 641-644).

so without any protective gesture (the fact that they are shown as being very close to the fire may be due to the craftsman who carved the decoration experiencing lack of space). This indicates that in reality the flames might not have been very high or could even have been all but absent, since the person at the left either is moving the loaves with a stick, or is adding wood to the fire (possibly the flames are only added to show that a fire was burning, as is done in some of the metallurgical scenes). Undoubtedly, the loaves are not lying directly in the fire, but in or over glowing charcoal, although Wild asserts that the baking of bread could take place even in a fire with open flames.⁵⁰

The scene in the chapel of *Nfr-hr-nj-ptḥ* shows the men sitting, baking bread on a brazier under a protective construction, yet they are baking the bread in the open field because the other men under the protection are doing work that is connected with the marshes.⁵¹

Bread could also be baked on pre-heated flat stones; for this, the same technique was used as for the pre-heating of *bd3* moulds. The result is that the hand could be raised here too in a kind of protecting gesture.

Apart from the pre-heating scene, none of the baking activities either requires or shows the gesture under discussion, and this would conform to a relatively low temperature of the bread moulds and the baking process itself.

3.4. The smelting of ore and the melting of metal⁵²

Another activity that made use of fire was the melting of metal or the smelting of ore. The melting of copper and gold, the most important metals in Egyptian society,⁵³ demanded very high internal temperatures (the melting point of copper is 1085 °C, and that of gold is 1064 °C). Copper, and also gold, can be found in their natural environment in the form either of native metal or chemically bound in minerals. The production of copper required several steps and the first one was the separation of copper from its basic minerals (e.g. malachite, a mineral which was mined first in the Sinai and later in the eastern desert too). Archaeological finds have demonstrated that, in order to avoid the transport of worthless bulk, the ore was refined where it had been mined, so that the metal that reached Egypt was already in an advanced state of refinement.⁵⁴ The melting of this metal required an interior crucible temperature of about 1090 °C depending on the composition of the base metal.⁵⁵

After this first step, the melting and processing of the metal thus partially refined could be done anywhere. However, this would require the same temperature as was needed for smelting. In order to reach these elevated temperatures special heating techniques were

⁵⁰ LÄ I, 594-598, s.v. “Backen”, 595.

⁵¹ Altenmüller, *Neferherenptah*, Pl. 1.

⁵² Melting is the heating of an already refined metal until it turns into its liquid form; smelting is the process whereby a native metal or its mineral is heated in order to separate it from surrounding impurities, the naturally occurring mineral aggregate in which it is found during mining.

⁵³ Silver is rare because local sources of ore or alloyed silver are not abundant in Egypt (Gale and Stos-Gale, *JEA* 67, 103-115) (Wikipedia, “silver mining”).

⁵⁴ Abd el-Rahman, *Archaeometry* 55(6), 1-21. This means that on the walls of the chapels only the melting of metal is depicted, because the smelting had been done elsewhere.

⁵⁵ The most commonly used fuel to reach this temperature was charcoal, which also served as a reducing reagent by chemically turning the copper-compound into metallic copper by combining with the oxygen in the ore to form carbon monoxide which was itself also a reducing agent and which, by combining with oxygen, was thereby turned into carbon dioxide.

needed: one of these made use of a crucible of a particular shape that is often depicted in decoration themes (Fig. 6).⁵⁶ Davey states that the fire to melt the metal was mainly inside the crucible.⁵⁷ The oxygen needed to keep the fire going was blown by metal workers into the small aperture at the underside of the crucible; this was done by means of a reed with a clay protection around the tip that was nearest the source of heat (Figs. 5 and 6).

Because the aperture into which the workers were blowing was small, it might be deduced that neither the heat nor the glare of the fire was so fierce that a protective gesture was necessary,⁵⁸ all the more so, since the blowing reeds were relatively long.

In some chapels the decoration shows the crucibles with flames around them, apparently indicating that the fire was on the outside (Fig. 7), but because the quantity of open fire around the crucible was minimal, this can be interpreted as a sign that the process employed high temperatures. The observation that this feature was not used in all of the depictions of the melting process indicates that adding the flames was not of great importance, and was just symbolic because in reality the outside of these crucibles was not extremely hot.

The melting was not always done with a crucible in the form given in Figure 6; in the tomb of *Pth-šps* (PM III/1, 340-342) melting equipment is depicted that looks like a pile (possibly a mud brick construction) covered on top with what looks like *bdj* moulds, which could possibly radiate more surface heat, but apparently not so much that in this situation a protective gesture was needed.⁵⁹ For the production or restoration of smaller implements made of copper, *bdj* moulds surrounded by glowing charcoal were used; this process apparently produced little smoke because archaeological proof has been obtained showing that this was done in inhabited areas.⁶⁰

The final step of the copper production process was a purification that is called “poling”;⁶¹ and it is proposed that this action is depicted in the tomb of *nh-m'-Hr* (PM III/2, 512-515) where it is presumably done by the standing person in Figure 5. However, for the process of poling a more realistic place to insert the pole would be from the opened top of the crucible, and also the “poking-angle” is incorrect. The observation that it is directed at the underside of the crucible instead of at its top leads to the conclusion that it is more probable that the activity of the standing man was to shed the clay disc that closed the crucible, an activity that made him go nearer the source of heat, thus provoking the protective gesture. In the mastaba of *Mrrw-k3.j* (PM III/2, 525-534) this activity has been depicted in a more realistic manner: the crucible is lifted and just before pouring out the molten metal the closing disc is poked out (Fig. 6).⁶²

The fire was mainly inside the crucible and little smoke was produced during the process; this could have meant that the persons who carried out this activity while using this type of

⁵⁶ Davey, in Maddin (ed.), *Metals and Alloys*.

⁵⁷ Davey, in Evans (ed.), *Ancient Memphis*, 85-107.

⁵⁸ Davey, *Proceedings of the Royal Society of Victoria* 120(1), 149.

⁵⁹ Verner, *Abusir* 1, Fig. 27. The fact that only two persons are blowing into the crucible and that it is clearly covered by *bdj* moulds can be explained by assuming that just a small quantity of copper had to be melted.

⁶⁰ Lehner, in Lehner and Wetterstrom (eds.), *GPMP* I, 33-35, 311 (“copper”).

⁶¹ For a further discussion of the poling process, see Wikipedia, “Poling (metallurgy)”.

⁶² Like in Fig. 5 also here two actions are depicted simultaneously. The remark in Swinton, in McFarlane and Mourad (eds.), *Behind the Scenes*, caption Fig. 4 (p. 172) stating “....worker using a stick to control the flow,....” is meaningless because the flow of the liquid can be controlled in a far less dangerous way by tilting the crucible.



Fig. 5. Tomb of *'nh-m'-Hr* (PM III/2, 512-515); Badawy, *Ankhhmahor*, Fig. 32, Pl. 37.

crucible were not located at the south side of the workshop. In that case the men would have been protected from the direct light of the sun by the roofed over construction of the working area.⁶³ If the various phases of the metal working process are combined, there is only one phase in which the protective gesture is presented. In the depiction in Fig. 5 the position of the hand and the direction of the standing man's gaze clearly indicate that the position of the hand is meant for the protection of the face from the heat of the fire and that there was no connection with the light of the sun.

Usually the upper hand holding the blowing reed was presented in a way that clearly showed that it was not protecting the face but just holding the reed with two hands, one of them close to the mouth. Davey proposes that the hand near the mouth was necessary in order to close the reed while breathing in, in order to avoid hot and noxious gases from the crucible entering the lungs.⁶⁴ In some presentations the blowing reed was held with one hand underneath while the upper hand gives the impression of not holding the reed but of being raised in a gesture seemingly intended to protect the face (Figure 5, the two men at the left side). In view of the various representations of the position of the hand near the mouth-end of the blowing reed, it can be concluded that each of them is just another way of depicting the hand holding the blowing reed.

The explanation for the various presentations of the crucibles for the melting of metal might be that the choice of firing techniques, and thus the equipment portrayed, depended on the temperature required and on the quantity of metal to be melted.⁶⁵

⁶³ That some phases of the metal-working process were done in a roofed over part of the workshop can be seen in Badawy, *Ankhhmahor*, Pl. 32, where a person weighing and a scribe recording are depicted.

⁶⁴ Davey, *Proceedings of the Royal Society of Victoria* 120(1), 147. This proposition would be based on an upward draft from the crucible to the mouth-end of the reed. Apart from the visible smoke, invisible gasses and particulate matter that were toxic and for the most part undetectable could escape the crucible (e.g. the particulate matter was dust of the toxic substances arsenic, mercury and cadmium). Depending on the source of the ore the smell-detectable and toxic gas sulfur dioxide could be present (the compounds making up the copper ores from the Sinai and the eastern desert are not based on sulphides and are thus low in sulphur content, but they contain arsenic).

⁶⁵ The amount of charcoal available was also a relevant point because sometimes it had to be imported.

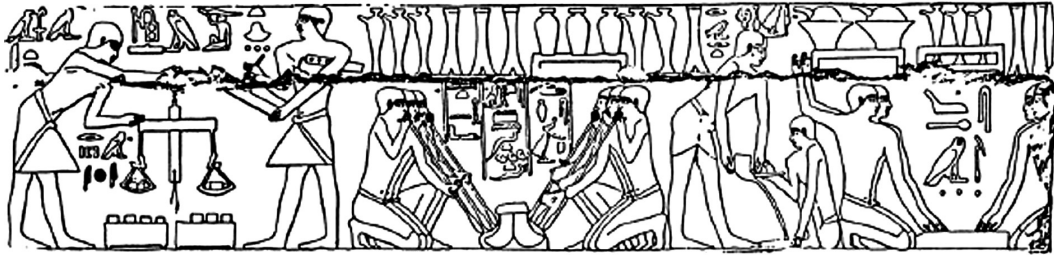


Fig. 6. The melting of metal in the tomb of *Mrrw-k3.j* (PM III/2, 525-534); Duell, *Mereruka I*, Pls. 2-3.

This proposition is supported by the fact that the (double) crucible as depicted in the chapel of *Mrrw-k3.j* (PM III/2, 525-534; date: VI.E) (Fig. 6) was already available during the period IV.L (*Nb-m-3ht*, PM III/1, 230-232; date IV.L-V.1),⁶⁶ yet, at the same time use was made of other forms of firing equipment.

- In the tomb of *Mr.s-‘nh* [III] (PM III/1, 197-199) the crucible in which the metal is melted has a round top, which could be a *bd3* pot, but may just be an indication of the opening in the top of the melting equipment. The activity takes place under a protecting roof, a scene that is rare.⁶⁷
- In the tomb of *Pth-šps* (PM III/1, 340-342) the fire is covered with what appears to be several *bd3* pots;⁶⁸ this might have been done in order to confine the heat. As previously stated, another explanation for the pots might be that, due to the greater leakage of heat, it is a depiction of the re-heating (and not melting) of copper vessels that had already been made, a process that would not require an extremely high temperature.⁶⁹

The conclusion is that the choice of firing equipment determined the extent to which the craftsmen were exposed to stronger heat radiation from the surface of the crucible.⁷⁰ However, this problem could be addressed by using a longer blowing reed. Apparently, if properly interpreted, opening the crucible was the only step in the whole metal-working process that necessitated the heat protecting gesture.

As already proposed, the raised hand could be intended to convey the idea that these persons were working with high temperatures, as evidenced in the chapel of *Tjj* (PM III/2, 468-478) (Fig. 7) and in the chapel of *Nj-‘nh-Hnmw* and *Hnmw-htp* (PM III/2, 641-644) where the outside of the crucible is covered in flames, which, in view of the type of crucible, is not completely realistic. Yet, the scene in Fig. 7 contains two sub-scenes that are contradictory:

⁶⁶ Lepsius, *Denkmäler* II, 13. The form can be interpreted as two crucibles depicted back to back as in Fig. 6 and covered to confine the heat.

⁶⁷ Dunham and Simpson, *Gmast* 1, Fig. 5.

⁶⁸ Verner, *Abusir* 1, 52, Fig. 28 states that *bd3* pots were placed on the fire to confine the heat (the crucible is depicted covered by the pots). This might be the reason why a protective gesture from heat and glare was not necessary.

⁶⁹ Davey, in Evans (ed.), *Ancient Memphis*, 100.

⁷⁰ Davey, *Proceedings of the Royal Society of Victoria* 120(1), 150-151.



Fig. 7. Flames around the double crucible
(chapel of *Tjii*, (PM III/2, 468-478)).

the crucible is covered in flames, and if this is an image that accurately reflects reality, then its outside would have been extremely hot and could not have been picked up with (nearly?) “bare” (?) hands as is shown in the sub-scene to the right.⁷¹

3.5. The grilling and cooking of meat⁷²

3.5.1. *The grilling of meat*

In the scenes depicting the grilling of meat, because the person doing the grilling usually holds a spit in one hand and a fan in the other (Fig. 8) the “protective” gesture is rare,⁷³ and even if the person has his hands free, the face is not protected.⁷⁴ Roasting meat was done on an open fire, mostly of charcoal, and consequently needs an adapted type of equipment (Fig. 8). It is understandable that during this type of activity the protecting gesture was not deemed necessary, either realistically or as a message, because the temperature of the fire could not have been too elevated without the risk of burning the meat. Consequently, not only is the heat generated by the device not high enough to necessitate protection, but also such a small charcoal fire does not generate a lot of smoke and can be placed under a roof, thus protecting the person tending the fire from the direct light of the sun.

3.5.2. *The cooking of meat*

In the mastaba of *Nb-k3w-Hr* (PM III/2, 627-629) part of the decoration of the northern wall of the pillared hall shows a man cooking geese; he is standing next to a brazier and is fanning the fire within. He holds the fan with both hands thus showing that the gesture of the protecting raised hand was not necessary during this activity.⁷⁵

⁷¹ Davey, *Proceedings of the Royal Society of Victoria* 120(1), 146. Swinton, in McFarlane and Mourad (eds.), *Behind the Scenes*, Fig. 4 (p. 172) shows that the man pouring out the molten metal has a form of protection between his hands and the crucible.

⁷² The term “meat” employed in this section means fish, fowl and meat from domesticated animals.

⁷³ Altenmüller, *Mehu*, 109-110, Pl. 16b.

⁷⁴ Kanawati, *Deir el-Gabrawi* 2, Pl. 50.

⁷⁵ El-Kerety, Strudwick and Strudwick (eds.), *Old Kingdom*, 3, Fig. 7.



Fig. 8. *Jj-mrjj* (PM III/1, 170-174, Plan XXIX, wall no.8; Lepsius, *Denkmäler* II, 52).



Fig. 9. The cooking of fish (Moussa and Altenmüller, *Nianchchnum*, Fig. 12).

In the chapel of *Nj-^ˁnh-Hnmw* and *Hnmw-htp* (PM III/2, 641-644) fish is cooked with the same type of equipment as in the tomb of *Jj-mrjj* (Fig. 9), the use of the poker shows that the fire is burning, and the man tending the fire does not protect his face.

The conclusion is that for these two food-preparing activities the fire is not hot enough to necessitate the protecting gesture.

4. Themes without a heat source

4.1. The protective gesture on ships

In the tomb of *Pth-špss* (PM III/1, 340-342) five ships are depicted and on one of them two members of the crew are making a gesture as if they are protecting their eyes against the sun (Fig. 10).⁷⁶

The figure on the cabin is undoubtedly a lookout and if the ships are southward bound his gesture suggests that he is protecting his eyes against the sun or the sheen of the light on the water in order to be able to see what happens at a greater distance. However, the person sitting next to the entrance of the cabin is probably a servant with no other function than being ready on call for the person inside. The gesture is only meant to keep the sunlight out of his eyes.

The gesture is also depicted in the chapels of *Mr.s-^ˁnh* [III] (PM III/1, 197-199),⁷⁷ *K3-nj-nswt* [I] (PM III/1, 78-79),⁷⁸ and probably in the chapel of *Sšm-nfr* [I] (PM III/1, 142-143).⁷⁹

⁷⁶ Verner, *Abusir* 1, 14-15.

⁷⁷ Dunham and Simpson, *Gmast* 1, Fig. 5.

⁷⁸ Junker, *Giza* I, Fig. 22 (p. 156).

⁷⁹ Lepsius, *Denkmäler* II, 28. Kanawati, *Giza* I, Pl. 44.

In the chapel of *Nfr* (PM III/2, 639-641) the raising of the hand of the man on the ship's prow is presented in a somewhat different way (Fig. 11).⁸⁰

In most of the depictions cited above, the sailing direction of the ships and the protective gesture made by the member(s) of the crew are in concordance:

- In the chapel of *K3-nj-nswt* [I] the ship depicted is sailing and thus must be navigating south, since in the literature it is stated that a ship is sailed when it is southward bound and that the ship is rowed when it is headed north.⁸¹
- In the chapel of *Mr.s-ḥ* [III] in the top register in the sub-theme to the right, the seated tomb owner is looking in the direction of the bow of the ship, while the literature states that the figure behind her is holding a sunshade.⁸² Strictly speaking this would indicate that the ship is headed north navigating down-stream, and the ship is being rowed for control.

In the lower register the situation seems to be the reverse. Because the ships have no sails the number of rowers is considerably larger than in the top register, which probably indicates that they are navigating counter-current, a situation corroborated by the fact that the watch-man is protecting his eyes from the sun in order to look ahead.⁸³

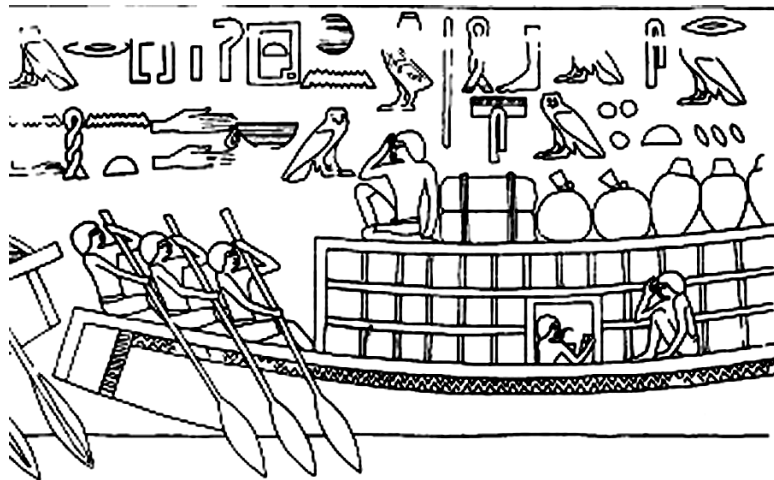


Figure 10. Protecting from the sun in the mastaba of *Pḥ-šps* (PM III/1, 340-2) Verner, *Abusir* 1, Fig. 3.⁸⁴

⁸⁰ Moussa and Altenmüller, *Nefer*. The distorted posture of the right arm stems from the convention of not depicting an arm in front of the face.

⁸¹ *LÄ V*, 613-616, s.v. "Schiffahrt", 613. An analysis of Graham demonstrates that there is not always concordance between the manner of propulsion of the ship and the direction in which it is sailing (Graham, in Piquette and Love (eds.), *Current Research in Egyptology 2003*, 41-56).

⁸² Dunham and Simpson, *Gmast* 1, 12.

⁸³ McFarlane and Mourad, *Behind the Scenes*, Fig. 5 (p. 150) concludes that all four ships are navigating to the north, although the direction of depiction is not conclusive.

⁸⁴ Courtesy of the Czech Institute of Egyptology, Charles University, Prague.

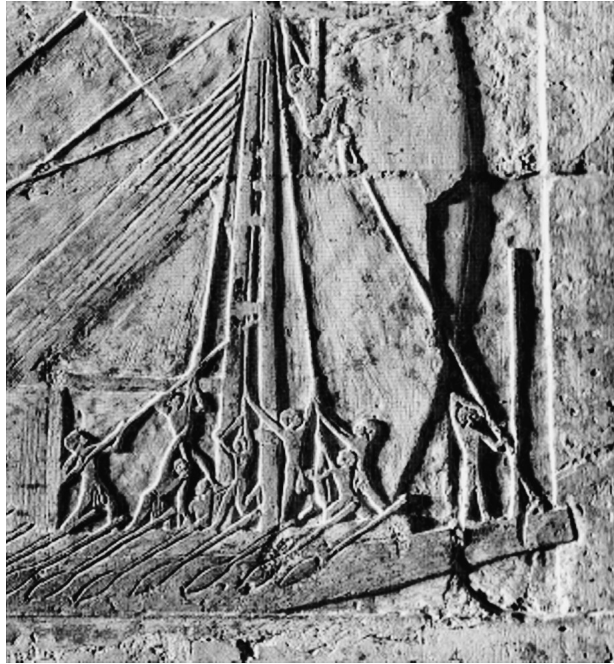


Fig. 11. Chapel of the rock-cut tomb of *Nfr*
(PM III/2, 639-641).

- The ship represented in the chapel of *Nfr* (PM III/2, 639-641) has hoisted the sails and the man on the bow is raising his hand above the eyes (Fig. 11); these two observations combined indicate that the ship is sailing to the south and that the gesture of the man is meant to take away the glow of the sun or that of its reflection on the water.
- The depiction of the ships in the chapel of *Pth-špss* is problematic (Fig. 10): the ship carries no sail and has to be rowed whether southward or northward bound. In Fig. 10 the number of rowers (3-4 = 6-8) is small compared to the number of 13 (= 26) rowers depicted in some of the corresponding scenes in the chapel of *Mhw* (PM III/2, 619-622).⁸⁵ The difference is that the ship of *Mhw* is for his personal transport while the ship represented in the mastaba of *Pth-špss* is meant for cargo and is smaller and lighter and thus needs fewer rowers. Therefore, it is probable that the ship of *Pth-špss* is navigating to the south, with the pilot protecting his eyes from the sun.
- In the chapel of *Sšm-nfr* [I], on the bow of each of two ships sailing in each other's wake, men are standing with what seems to be raised hands. The hands are raised to a height that could protect the face from the setting sun, but, in view of the caption near the man in the ship that follows, it could also mean that he is shouting to someone on the ship in front of him.

⁸⁵ Altenmüller, *Mehu*. Pl. 20.

4.2. The gesture while weighing ore or metal

Weighing ore or metal is one of the sub-themes of the metallurgical process: although the weighing itself is relatively often depicted, this activity with a hand raised in protection is rare (in OEE, metal work, weighing lumps or ingots of metal 12 scenes are given of which only one tomb depicts the scene with a person raising his hand).⁸⁶ The absence of a protecting roof, and the hand which is sufficiently raised to be interpreted as protecting from the sunlight, combined with the scarcity of depictions of this aspect of the scene, indicates that normally the weighing was done inside protected from sunlight (and undoubtedly from wind).⁸⁷

The gesture depicted in the weighing scene in Badawy's excavation report of the mastaba of *'nh-m'-Ir* (PM III/2, 512-515) is not protective, but shows the steadying of the arm holding the balance.⁸⁸

5. Conclusions

The activities that require fire in order to be executed can be divided in two groups based on the temperature experienced by the person(s) working on it:⁸⁹

- A. Low-temperature activities:
 1. The baking of bread
 2. The cooking or baking of meat, fish and fowl.

- B. High-temperature activities:
 1. Manufacture of pottery (e.g. beer jars or bread moulds) in a kiln.
 2. Pre-heating of bread moulds.
 3. Pre-heating of flat stones to bake bread on.
 4. Smelting of ore or melting of metal.

Although the pottery kiln (activity B.1) is a relatively closed construction (the only openings being the one in the top and the fuel opening at the bottom), after a certain time the heat of the fire within causes the kiln's surface to start radiating heat. As with the pre-heating activities, the smoke developed in this type of equipment is considerable,⁹⁰ thus making it probable that these two characteristics might have resulted in this activity being "banned" to the southern part of the working area. Because the height of a kiln cannot be determined from the sparse depictions that have survived time and destruction,⁹¹ it is not clear whether the face of the person tending the fire, who was sitting north of the kiln, was exposed to the sun, or whether the gesture was meant to protect the face from the heat (Fig. 1, 7th register). Taking into account the geographic latitude of Egypt, certainly during summer the midday sun was

⁸⁶ Brovarski, in Der Manuelian and Simpson (eds.), *Gmast* 7, Fig. 116b.

⁸⁷ Badawy, *Ankhamhor*, Pl. 32.

⁸⁸ Badawy, *Ankhamhor*, Pl. 36.

⁸⁹ Because this study focuses on one specific type of human reaction to radiated heat, data about the interior temperature of the heating equipment need not be included in the formation of the conclusion.

⁹⁰ Nicholson, in Wendrich *et al.* (eds.), *UCLA Encyclopedia of Egyptology*, Fig. 6.

⁹¹ It is not clear whether the height of the tending person and that of the kiln have been depicted in proportion.

extremely high in the sky and in order to find some shade behind the kiln the person tending the fire would have to be uncomfortably close to it. This consideration makes it highly probable that the person was in fact exposed to the full glare of the sun during the major part of the day.

According to the representations available, the piles of bread moulds or flat stones that were in the process of pre-heating (B.2 and B.3) were temporary structures of a considerable height.⁹² Consequently, this could not be heated with a layer of glowing charcoal; the height necessitated an open fire of wood which would give off a lot of smoke (which is a mixture of carbon dioxide, steam and soot).

The next high-temperature process (B.4) is, due to the metallurgical technology of the adapted crucible, a process of low external heat and little smoke, and thus is not in need of a protective gesture.

Based on the temperatures required, the melting of metal would be an activity involving high temperatures, but the crucibles used for this work were such that the direct external radiation of heat was minimal. The fire was confined to the interior of the crucible with a small amount of charcoal around the opening in order to pre-heat the air blown into the furnace. This overall setup ensured that the production of heat and smoke was minimal, making a protective gesture unnecessary. The observation that this step in the process was mainly placed outside the workshop is probably caused by the (bad-smelling and irritating) fumes given off by the melting metal.

The conclusion is that there are only three fire-requiring activities that do show the gesture of the raised hand (B.1, B.2 and B.3). Due to the way the necessary high temperatures for these processes were reached, a relatively large amount of smoke and heat was produced. They were therefore limited to the extreme southern end of the working area, the area where people were directly exposed to the sun. Yet, the people working there would remain subjected to the smoke and to the heat of the fire, while being outside exposed them to the sun too. But the nearly permanent prevailing wind carried away the heat and the smoke, thus leaving only the sun. The conclusion from these arguments is that the gesture is meant solely to protect from the sun and *not* from the glow of the fire.

The above proposed conclusion is strengthened by the following arguments:

- The observation that themes without sources of heat, like those with ships sailing or rowing southward or the weighing scene (Fig. 12, nos. 9 and 10), show the gesture anyway, which in this case can only be meant as protection from the sun. In Fig. 12 it is evident that only the outside activities show the protective gesture.
- In both two- and three-dimensional depictions of the high temperature pre-heating activities (Fig. 12, nos. 2 and 3) sometimes the “protective” hand appears not only to be raised too high to protect the face against the heat of the fire, but there are also examples in which it is placed at one side of the head. The latter can be interpreted as the hand taking away the glare of the sun on particular hours of the day, like the early morning or late afternoon, thus making the gesture protective from the light of

⁹² In models the piles reach between the knees and the shoulders of a person sitting in front of it (Museo Egizio Turin, no. 13271; MFA 21.2600).

the sun and not from the heat or the gleam of the fire.⁹³ In some statues this gesture is combined with the person looking away from the fire (Fig. 3), indicating a simultaneous protection against the glare of the fire and the light of the sun, the hand protecting from the sun and the turning of the head protecting from the fire.

	type of heat source	fuel		high temperature		smoke	sunlight	gesture	In side	Out side
		wood	charcoal	intern	extern					
1	Pottery kiln	x			x	x	x	x		x
2	Pre-heating bread moulds over open fire	x			x	x	x	x		x
3	Pre-heating stone disks over open fire	x			x	x	x	x		x
4	Pre-heating bread moulds over brazier		x						x	
5	Melting metal/ore		x	x					x	
6	Baking bread over open fire		x						x	
7	Cooking meat/fish/fowl		x (?)						x	
8	Roasting meat/fish/fowl		x						x	
	type of scene						sunlight	gesture		
9	Navigation						x	x		
10	Weighing						x	x		

Fig. 12. Compilation of the various factors connected with the protective gesture.⁹⁴

⁹³ In Simpson, *Gmast 2*, Fig. 38, the two persons tending the fire that pre-heats the *bd3* and *pr.t* bread moulds are turning their heads away; in the accompanying captions there is no mention of them talking to the person behind them, so the gesture can be interpreted as both raising the hand toward the sun and looking away from the fire (for text: *Ibidem*, p. 26).

⁹⁴ In the table of Fig. 12 a point of doubt is the cooking of meat, fish or fowl because, due to the absence of indications in the depictions, it cannot be determined with certainty whether this was done using wood or charcoal as fuel. Stating the interior temperature of the fire is irrelevant within the context of this study, since the temperatures experienced by persons in the vicinity of the source of heat cannot be known because these data are highly dependent on variable external factors (chill factor).

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