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A Proposed Relationship Between Circumcision and Neural Reorganization

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ABSTRACT. Humans are intensely biocultural beings. The linkages and causal feedback loops among their symbolic world, their cultural world, and their physical bodies can be exquisitely complex and subtle. It is suggested in this article that one cultural event—circumcision—exemplifies that subtlety and complexity. It is hypothesized that circumcision reorganizes the male's sensory somato-cortex to raise the threshold of sexual excitability/distraction. This threshold shift thereby allows the young men of a social group (a) to be slightly more tractable in executing corporate activities beneficial to the community and (b) to be slightly more restrained sexually and more cooperative in the pair bond. The practice is accepted because the procedure is deeply enmeshed in the ritual and symbolic life of the social group and is applicable to all young males. Suggestions are made on how to test this hypothesis empirically.

ALTHOUGH THE NATURE-NURTURE PROBLEM has had an uneven history, there is consensus on one element within the overall argument: behavior, including motivation, is mediated through the central nervous system. Hence, changes in the central nervous system are aligned with changes in behavior. The correspondence is, of course, not necessarily a one-to-one relationship. Nevertheless, it is clear that nontrivial reorganization or lesions to the central nervous system affect behavioral outputs. Depending on the locus of the neural shifts, the change can be in sensory perceptions, internal analysis, or motor outputs.

It is also clear that cultural inputs that surround and immerse the individual are analyzed by his or her central nervous system, and culturally appropriate behaviors are typically emitted. Distinct cultures have their own distinct inputs, implemented via cultural traditions, and individuals will typically behave with the appropriate, culturally sanctioned behaviors.

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In this article, we offer an attempt to link a cultural ritual—circumcision—with behavioral changes. The act of circumcision itself is deeply enmeshed in a culture's symboling system. The behavioral changes are purposed to be mediated by neural changes.

Circumcision: Cultural Rituals

Circumcision involves the permanent removal of the foreskin of the male—invariably a young male and often an infant. Diverse religions and cultures have included circumcision in their ritual and religious worlds: Judaism, Islam, tribes in sub-Saharan Africa, tribes of Australian aborigines (Murdock, 1957; for a history and geography of circumcision, see Bryk, 1934). Each group has developed an elaborate set of images, metaphors, symbols, and rationales for circumcision. (For Moslem examples, see Pierce, 1964; Bowen & Early, 1993; cf. Abu-Sahlieh, 1994; for sub-Saharan African examples, see Turnbull, 1962; Winter, 1959; for an Australian aboriginal example, see Tonkinson, 1978. For a biocultural overview, see Immerman & Mackey, in press. For a map of the distribution of levels of circumcision in contemporary sub-Saharan Africa, see Caldwell & Caldwell, 1996. For a Freudian interpretation, see Young, 1962. For the history in the United States of the ongoing medical debate on the value of circumcision, see Gollaher, 1994. For the various positions of the current medical debate on the benefits and costs of circumcision, see Mansfield, Hueston, & Rudy, 1995; Roberts, 1996; Spach, Stapleton, & Stamm, 1992; Taddio, Goldbach, Ipp, Stevens, & Koren, 1995; Taddio et al., 1997; Weiss & Weiss, 1994; Wiswell, 1997; cf. Szasz, 1996.)

Circumcision from the Jewish perspective. The written history of Jewish circumcision is both long and rich and illustrates well the ornate cultural context that surrounds the physical procedure itself. The *Encyclopaedia Judaica* (1972, pp. 568–576) gives the following perspective on circumcision in Judaism. It originated, according to the Biblical account, from a divine behest. From Genesis 17: 11–12 comes the prescription: "Every male among you shall be circumcised. And ye shall be circumcised in the flesh of our foreskin, and it shall be a token of a covenant betwixt Me and you. And he that is eight days old shall be circumcised among you, every male throughout your generations." The covenant involved a promise that Abraham's lineage would be multitudinous and that these multitudes would inherit the land of Canaan if Abraham and his descendants would practice circumcision. Abraham circumcised himself, his son Ishmael, all the males of his household, and his slaves. In the following year, Abraham's second son, Isaac, was born and was circumcised at eight days old. Circumcision was considered so important that the rabbis taught that were it not for the blood of the covenant (circumcision), heaven and earth would not exist. The ritual of circumcision was and is viewed as a sign of faith. Any perceived medical overlay of the practice occurred only recently.

Complementing any religious–symbolic function, the biological question remains: "What consequences occur by the removal of the human foreskin?"

Biological and Cultural Consequences of Circumcision

Biological consequences. The relevant but sparse literature that deals with the human foreskin tends to tacitly refer to it as a mere flap of skin. Anatomically, however, this reference is not accurate. The intact human foreskin is richly innervated and contains holocrine glands (e.g., Tyson's glands). (For reviews of the development of sensory nerve endings in the human penis, see Dail & Evan, 1974; Halata & Munger, 1986; Sommerova, 1976.) In terms of surface area, the human foreskin represents approximately 36%—more than one third—of the intact penis's skin (Ritter, 1992; also see Taylor, Lockwood, & Taylor, 1996). As a facet of the man's reproductive apparatus, the foreskin seems nontrivial.

Sensation is localized within the brain. If circumcision affects the sensory pathways of the brain, then the implication should be strong that subsequent sexual sensations will also be affected. Studies on the triangulation of the foreskin, the central nervous system, and circumcision have yet to be conducted or, at least, are not easily located. Nonetheless, inferential evidence is available.

Lesions and cortical reorganization. Researchers have demonstrated that if an animal's digit is removed or de-afferentated, the somato–sensory area that serves that digit is both structurally and functionally reorganized, sometimes extensively (e.g., Doetsch, Johnston, & Hannan, 1990; Doetsch, Standage, Johnston, & Lin, 1988; Kelahen & Doetsch, 1984; Kelahen, Ray, Carson, Massey, & Doetsch, 1981; Welker & Seidenstein, 1959). The effects of the digit removal are greater if the trauma occurs early in the organism's development (cf. Florence et al., 1996; Garraghty & Kaas, 1991). The reorganization of the cortex is generally not orderly. Cortical cells that serve the areas adjacent to the removed/de-afferentated digit expand their influence into the region of the cortex that would have served the affected digit. The expansion seems stochastic rather than pre-ordered or patterned.

In addition, as was shown in monkeys, when the affected, damaged area or areas adjacent to the damaged area are stimulated, the threshold for activating the relevant cortical cells is often higher (Wall, Huerta, & Kaas, 1992). Subcortical areas (e.g., the thalamus; Florence & Kaas, 1995; Garraghty & Kaas, 1991) that project to the somato-sensory cortex are also reorganized. Given that the thalamus is a primary sensory "switchboard" for the brain, any reorganization at this subcortical level would be expected to influence both cortical and subcortical functioning.

When nerves that innervated the hands of monkeys were severed, the cortical-sensory areas serving those hands did not recover responsiveness to cutaneous stimuli (Huerta & Wall, 1987; Wall & Kaas, 1986; also see Pons et al., 1991; cf. Jackson & Diamond, 1981). After de-afferenting digits of the squirrel monkey, Garraghty, Hanes, Florence, and Kaas (1994) noted that much of the sensory cortex normally activated by the removed digit remained unresponsive to cutaneous stimulation. Garraghty et al. concluded that there is a limit to the scope of new receptive fields that cortical neurons can acquire. (For a similar discussion on the owl monkey, see Wall, Kaas, Sur, et al., 1986.) Wall and Kaas (1986) and Wall, Huerta, and Kaas (1992) offered corroborating evidence and interpretation.

Florence, Wall, Garraghty, and Kaas (1988) noted that nerve regeneration is often incomplete and disorderly and that the remaining area of the somato-cortex becomes reorganized. Large zones of such "silent" cortex persist over time. Similar reorganization of the somato-sensory cortex (after amputation of a digit or after severing nerves) has been reported for cats (Kalaska & Pomeranz, 1982; Metzler & Marks, 1979) and rats (Cusick, 1996; Cusick, Wall, Whiting, & Wiley, 1990; Rhoades, Wall, Chiala, Bennett-Clarke, & Killackey, 1993; Wall & Cusick, 1984).

It appears that any sensory deprivation of a system can also lead to cortical changes. For example, Kandel (1991) noted in his work with ocular dominance that

> If one eye is closed during a critical period, the columns [of neurons in the visual cortex] devoted to that eye *shrink* while those devoted to the open eye *expand*. This modifiability of the ocular dominance columns is restricted to a relatively short period just after birth (p. 1024; emphasis added)

(See Jessell, 1991, for an overview of neuronal reactions to injury.) It is also useful to note that the phantom limb phenomenon (Melzack, 1992) has not been reported or found regarding the circumcised foreskin.

In a review of the literature on the plasticity or malleability of sensory maps, Kaas (1991) offered the following summary:

(a) Reorganization of sensory maps in the brain follows changes in neural activity patterns induced by the relative inactivation of feed forward pathways produced by lesions or by the removal of the (i) sensory surfaces, (ii) peripheral nerves, or (iii) more central structures.

(b) Sensory maps in the brain, both early and late in processing hierarchies, are mutable, but such changes are more dramatic in higher stations. The increased level of change in these higher areas, closer to the cortex, may be because of the accumulation of serial changes and/or the greater potential plasticity.

(c) Sensory maps in the *somato-sensory* visual and auditory systems in the brain are all capable of change.

(d) Sensory maps within the brain have been shown to change in a wide range of mammalian species (e.g., raccoons, monkeys, rats, cats et al.). The clear implication is that adult plasticity is a feature of all mammalian brains. And, as a large reservoir of data demonstrates, the younger the individual is, the greater is the plasticity in the development of the nervous system. See Kandel, Schwartz, & Jessell (1991) for examples.

(e) There is presently little evidence related to the *behavioral* consequences of the reorganization of maps in the brain. Nevertheless, partial recoveries of lost abilities which follow central damage include the possibilities of alterations and improvements in sensory skills.

Synopsis. Framed a little differently within the context of circumcision, the removal of the foreskin would be expected to reorganize the somato-sensory cortex of the brain of the affected individual. Because sexual stimuli normally travel to the cerebral cortex via the thalamus and then to those subcortical areas that are aligned with emotion—for example, the septum (Rivard, 1982)—any reorganization of the cerebral cortex would be expected to affect the overall sexual behavior of that individual (for supporting evidence, see Laumann, Masi, & Zuckerman, 1997; cf. Masters & Johnson, 1966). The earlier in the male's life the circumcision occurs, the more impact the ablation would be expected to have on his nervous system and, hence, his behavioral tendencies.

Thus, we argue here that removal of an individual's foreskin has consequences in that person's brain. The removal of the foreskin—part of the male's reproductive apparatus—is hypothesized to affect sexual excitability. The most intuitive direction of any change would be to lower excitability or raise the threshold for sexual arousal.

Circumcision and skin texture. A result of circumcision is the keratinization and desensitization of the surface epithelium of the glans penis. In other words, if the moistening, protective covering of the glans penis were removed, then the skin on the surface of the glans penis would dry out and become toughened and callused. Again, the end result is a desensitization of the man's reproductive tissues. Excitability would be lowered, and the threshold for sexual arousal would be raised.

Benefits to the Community From Circumcision

Cultures, not unlike stars and species of flora and fauna, seem to have a life cycle. They are born. They flourish. They die. Large numbers of cultures from antiquity, such as the Aztecs, the Incas, the Maya, Pharaoh's Egypt, Socrates' Greece, Caesar's Rome, the Vikings, and Babylon, are no more. Some North American Indian tribes are gone. Extant South American Indian tribes are currently destined for eradication. To remain viable and competitive, intact cultural units must solve various communal problems: secure food (especially proteins); secure potable water; maintain internal cohesion and minimize internal disruption (especially caused by young, energetic males); and maintain defenses against marauding young, energetic males from competing groups (see Harris 1974a, 1974b, 1977, for examples of problems met and solutions found for various facets by a myriad of cultural groups).

We suggest that circumcision originated as a mechanism to lower, even if only slightly, sexual excitability/sexual distractions of young men. Because historical records will probably never be found and validated (circumcision was practiced in Pharaoh's Egypt and is thereby at least that ancient), the suggestion is not amenable to proof. Nonetheless, the argument is as follows.

The energy and aggressiveness of young men are valued assets in a society. Dangers from the young men of other groups need to be prevented, or, if not preventable, then thwarted. Internal tasks, such as communal hunts, require the young men's coordinated activities. If distractions from these tasks are minimized—not eliminated, just minimized—then the efficiency of the coordinated task is improved.

Sexual interest of young men in young women is a very real event. Sexual distraction and excitability for the individual man can certainly compete for his attention and focus. Circumcision could raise the threshold for sexual excitability and distraction. That is, circumcision would not eliminate the sex drive, it would just raise the threshold. (For the importance of "sensory" input to the brain from the man's genitalia for his effective sexual behavior, see Bemelmans et al., 1991; Gerstenberg, Nordling, Hald,.& Wagner, 1989; Rowland, Leentvaar, Blom, & Slob, 1991; Xin et al., 1996.) That is, sexual behavior (of males) is not simply motor/reflex driven.

Thus, the argument here is that circumcision is low-grade neurological castration. As a consequence of circumcision, the young men would be expected to be a ply more tractable and a ply less distractible. Fertility is not impaired. Aggressiveness is not impaired. The threshold for sexual excitability is simply raised.

Benefits to the Pair Bond From Circumcision

If, as we hypothesized, circumcision results in raising the threshold for sexual excitability, then a putative benefit would accrue to the institution of marriage. Men's sexual impulsiveness would be lessened a ply. Again, men's sex drive is not removed, just abated. Consequently, the men's sexual behaviors, which are traditionally viewed as quicker and more direct, would be shifted in the direction of the women's sexual behaviors, which are traditionally viewed as slower and less direct. In addition, extramarital sexual activity would be similarly expected to be reduced.[1] Enhanced sexual compatibility within a marriage generally enhances the durability and coordination within that marriage. Consequently, strengthened marriages would be a positive vector within any society.

The Trade-Offs Between the Man and His Society

The societal calculus and trade-offs are as follows: The individual male is denied some additional or more intense sexual feelings. The community gains

[1]An additional advantage to the community of reduced extramarital sexual relations—i.e., reduced numbers of sexual partners—is the concomitant reduction in sexually transmitted diseases. (See Immerman & Mackey, 1997, for a discussion on the threats to the commonweal's reproductive capabilities resulting from endemic sexually transmitted diseases.)

some additional compliance, and women gain some additional satisfaction within the pair bond. If all males are so affected within the group, no one male or cohort of males is at a courting or amorous disadvantage. The problem, of course, is how to convince parents that their sons' genitalia need to be mutilated. The next section addresses that legitimate query.

The Juggernaut of Cultural Inertia

The socialization process in humans begins at birth and is pervasive. Early learning—the systemization of the rules and worldview of a culture—is very resistant to re-systemization. That is, a process similar to imprinting is in evidence. (For classical discussion on imprinting, see Hess, 1973; Lorenz, 1958, 1965; Tinbergen, 1951, 1965; for current discussions, see Bolhuis & Horn, 1992; Bornstein, 1989; Bower, 1993; Cook, 1993; Leland, 1994; for specific discussions on human mating strategies, see Freedman & Gorman, 1993; Rossi & Rossi, 1990.) Once a child is enveloped in the cultural matrix, wherein each major institution reinforces every other major institution, the mind-set of the child is crystallized. As the child grows to maturity, cultural givens are not questioned, they simply "are" and are about as visible as the wind.

The child, grown to adulthood and parenthood, will pass on his learned givens to the next generation. The culture of a child is presented to that child in ways and by means a child can understand. For example, were the young Western child to ask, "Why is the sky blue?" or "Why cannot a brother marry his sister?" or "Why is dishonesty not the best policy?" the most effective answers adults can give are "because it is, because he can't, because it isn't . . . now go outside and play." Complex feedback loops of economic–political–social–psychological forces are well beyond the ken of all children to understand and most adults to convey. However, Rabbi Moses Maimonides (cited in Ritter, 1992), who was also a physician of note, clearly articulated our thesis in the 13th century, when he wrote about the Jewish version of circumcision:

> The bodily injury caused to that organ is exactly that which is desired; it does not interrupt any vital function, nor does it destroy the power of generation. Circumcision simply counteracts excessive lust; for there is no doubt that circumcision weakens the power of sexual excitement.

What is understood by young children is the concept of authority (Piaget, 1954, 1977). Children universally obey parents and elders. Once so inculcated, children are then predisposed to obey the supernatural, deceased ancestors, and omnipotent deities. If the unseen, powerful forces mandate circumcision, then circumcision it will be. Again, if all sons by all parents are affected, then the cultural rule will have less difficulty getting started and less difficulty in being maintained. There is no exception toward which parents can maneuver. If someone is a member of our group and is a young male, then ipso facto, that boy will be circumcised.

The Lack of Universality

The legitimate question can be raised, "If the procedure is beneficial to the competitiveness of a society, then why is the procedure not universal?" Part of the answer must lie in the variability of both humans and human culture. Circumcision is not found in cultures indigenous to northern climates. Arguably, a harsh winter, over time, selects for characteristics that obviate the need for added young male tractability (for theoretical discussions, see Calvin, 1990; Freedman, 1974, 1979). Similarly, cultural rules that systematically inhibit informal interaction between the sexes would preclude the need for an additional factor in tamping down young men's ardor. In short, there could well be alternative strategies that successfully cope with male sexual assertiveness.

A Hypothesis to Be Tested

The argument presented here has a number of assumptions and conclusions, some untested, some validated. The key untested conclusion is that a circumcised man's brain is reorganized and changed, compared with an uncircumcised man's brain. One of Popper's (1959, 1962) contributions to the philosophy of science is the recognition of the need for falsifiability. A good discipline generates falsifiable hypotheses; a poor discipline does not. With current technology, living tissue (e.g., the brain) can be studied in living individuals. The argument put forward by this thesis is that imaging of the brain via positron emission tomography (PET) and/or magnetic resonance imaging (MRI) could detect differences in the somato-sensory cortex when it receives stimuli from the genitalia of circumcised men compared with similar cortical areas of uncircumcised men. These differences ought to be structural as well as functional. Furthermore, additional differences may be detected in other areas of the brain that are involved in sexual functioning.

Were such a hypothesis to be unsupported, then Huxley's definition of a tragedy, "a beautiful theory killed by an ugly fact," would be fulfilled. On the other hand, were such a hypothesis to be supported, then the Gordian knot that interlinks human symboling, human behavior, and human neurophysiology can be unraveled one notch.

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