Learning to Smile: The Neuroanatomic Basis for Smile Training

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ABSTRACT

This article demonstrates that although any layperson could recognize that the smile manifests mainly in the oral and periorbital regions, a comprehension of the neurologic and musculoskeletal elements lends the clinician insight into the many aspects of a smile. The neurologic control of a smile consists of a complex process involving many facets. As with any other complex neuromuscular activity, repetitions of the act can train the central nervous system, neural network, and muscular network in efficient performance of and correct musculoskeletal activation involved in the act itself. With functional knowledge of muscles dedicated to a pleasing full smile, together with a battery of easy and effortless exercises, the clinician is able to help the patient change behavior intended to camouflage perceived oral flaws. A patient needs reassurance that behind the guidance from the clinician lies medical evidence that such routine movement of muscles will indeed improve the smile. When asked why or how the exercise succeeds, the clinician can reassure the patient based on a working knowledge of the neurologic and muscular anatomy involved.

CLINICAL SIGNIFICANCE

A functional knowledge of muscles dedicated to a pleasing full smile, together with a battery of easy and effortless exercises, provides the clinician with the ability to assist the patient in altering years of behavior intended to camouflage perceived oral flaws.

(*J Esthet Restor Dent* 13:20–27, 2001)

Smile, it makes people wonder what you're thinking. Anonymous

Wrinkles will only go where smiles have been. Jimmy Buffett

Have a Coke and a smile. Coca Cola advertisement

A frown is just a smile turned upside down. Anonymous

Poets and authors write about them. Artists capture them in paintings and sculptures. Advertisers use them to sell products. A smile projects happiness, joy, humor, pleasure, friendliness, acceptance, or agreement (Figure 1). Whatever the emotion, smiles represent an important function in society and for a variety of psychological reasons make the projector and the receiver of the smile feel good.[1] An impairment in smiling has been associated with a higher incidence of depression.[2] Dental deformities, such as diastemas (Figure 2, A), have forced many to either consciously or unconsciously cover the teeth with the lips, hiding the dentition and precluding a pleasing smile (Figure 2, B). In the authors' experience, the same holds true for missing, carious, or unsightly teeth.

For the past 5 years, in a series of approximately 50 patients, the dental clinician author has used an informal preoperative program of smile training in an effort to optimize the quality

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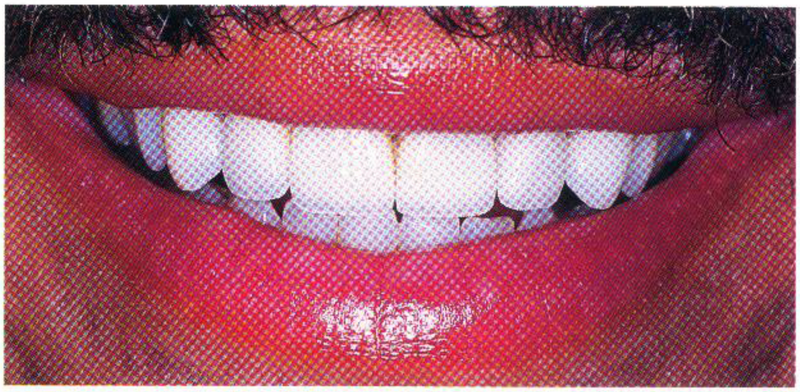

Figure 1. An example of an esthetically pleasing smile.

of pre- and post-reconstruction comparative photography. This has led to a more natural appearance of smiles and improved the ability to determine the relation of the lips and teeth and, thus, to an improved reconstruction. In addition to improved photographic documentation, these patients report great satisfaction with their postoperative appearance. This suggests that post-reconstruction smile training might help patients to improve their appearance.

Articles concerning the restoration of varying dental complications remain constant, yet few address the second facet of treatment: helping the patient learn to smile. This article attempts to provide insight to the clinician into the anatomy of a smile as well as some basic insight into training methods and use of that understanding in helping patients to achieve a pleasing smile.

NEUROLOGIC AND MUSCULOSKELETAL ANATOMY OF A SMILE

Though any layperson could recognize that the smile manifests mainly in the oral and periorbital regions, clinicians involved in smile restoration and training need a more detailed understanding of the neurologic and musculoskeletal elements involved in smiling to adequately understand and implement a comprehensive rehabilitative

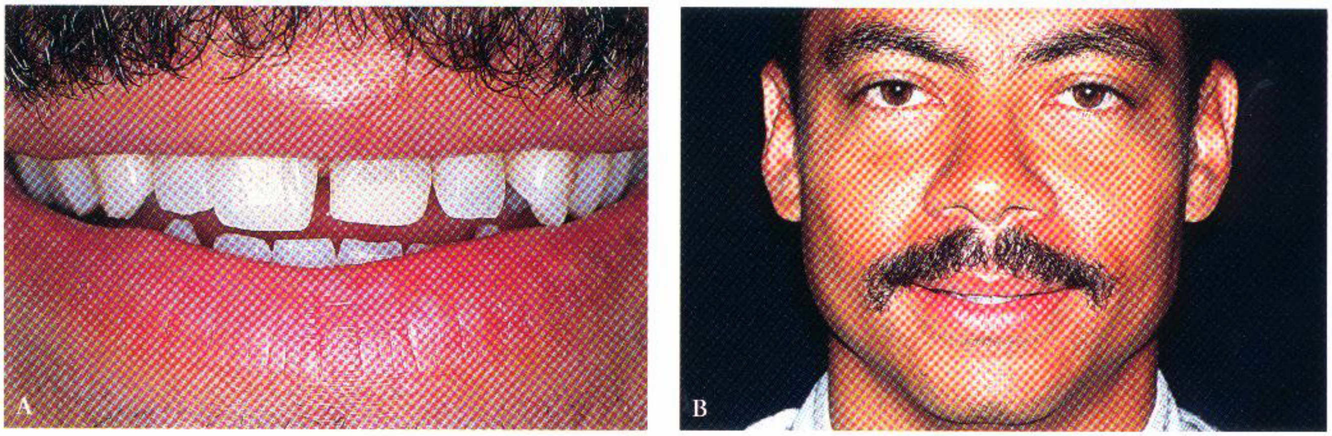

Figure 2. Any dental deformity, such as a diastema (A), may preclude a pleasing smile (B).

program. The neurologic control of a smile consists of a complex process involving many facets, the first of which originates in the central nervous system (CNS).

The conscious desire to smile arises in the nonmotor cerebral cortex in response to some external stimulus, such as a familiar face or a humorous anecdote. From the nonmotor cortex, the signal transmits to the premotor cortex, where processing and modification of the signal based on neural feedback takes place, and the motor impulses necessary to accomplish the planned task are generated. The premotor cortex functions primarily in the planning phase of muscular activation, determining which muscles to activate and what degree of activation is necessary. From the premotor cortex, signals are sent to the appropriate areas of the motor cortex, which is the primary CNS center of muscular control. The motor cortex passes the signal to the primary control center of facial expression: the facial nerve (seventh cranial nerve [CN VII]) nucleus.[3]

The nucleus of CN VII lies in the pons along the midline of the base of the fourth ventricle. Fibers from this nucleus pass anterolaterally through the pons to emerge at the junction of the pons with the medulla as the facial nerve.[3]

From this origin, the facial nerve moves anterolaterally upon the surface of the middle cerebellar peduncle and enters the bony skull. In the temporal bone, the outward course of the facial nerve is drastically altered as it passes the tympanum. The nerve bulges into the geniculate nucleus. The majority of the fibers of the facial nerve turn inferiorly in an arch posteriorly to the tympanum, exiting the temporal bone at the stylomastoid foramen. As the nerve emerges into the soft tissue of the head and neck, it runs forward through the substance of the parotid gland and across the external carotid artery. Just posteriorly to the ramus of the mandible, the nerve divides into the two primary branches: the temporofacial, which subdivides into the temporal, malar, and infraorbital nerves; and the cervicofacial, which subdivides into the buccal, supramaxillary, and inframaxillary nerves. These nerves branch into terminal motor nerves and insert into motor endplates on the muscles of expression (Figure 3).[4,5]

The so-called muscles of expression are superficially located sphincter and dilator muscles that control the skin and soft tissue surrounding and overlying orifices in the head. The primary intent of these muscles is protective and functional, such as the orbicularis oculi, which tightly closes the eye both consciously and as a reflex,

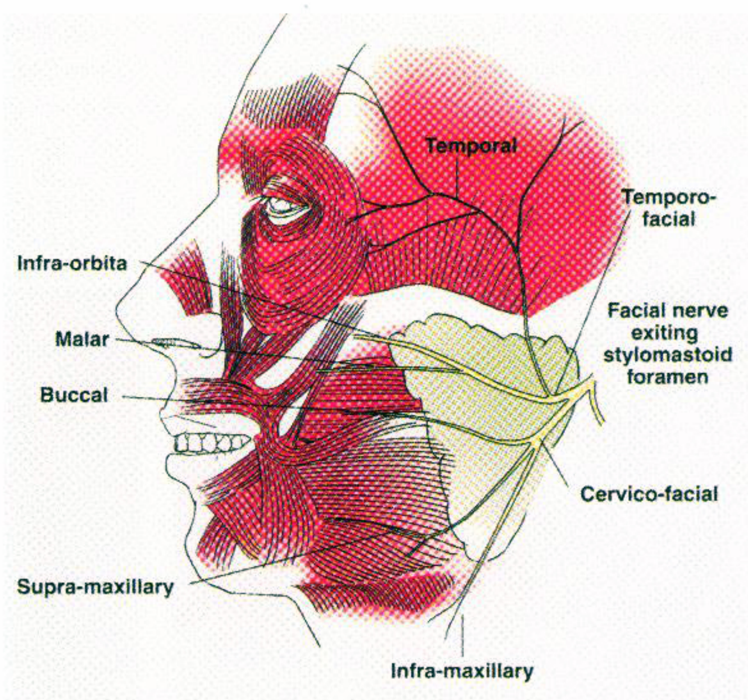

Figure 3. Major divisions of the facial nerve (cranial nerve VII).

and the buccinator, which functions to mobilize food during eating. A second function of these muscles is to provide expression to the face, which may also be thought of as a protective mechanism, both for prehistoric man and in modern society.

There is a long list of muscles involved in expression, starting superiorly with the frontalis muscle and ending inferiorly at the chin with the mentalis muscle (Figure 4). All of the muscles of the face play a part in a smile, but the primary muscles involved in smiling are the zygomaticus major, levator labii superioris, and the levator anguli oris. Additionally, the periocular muscles may be recruited to provide maximal elevation of the lip. This gives the appearance of squinting that accompanies some smiles and leads to "smile lines," the name given to the small periocular wrinkles that develop with age.[4,6]

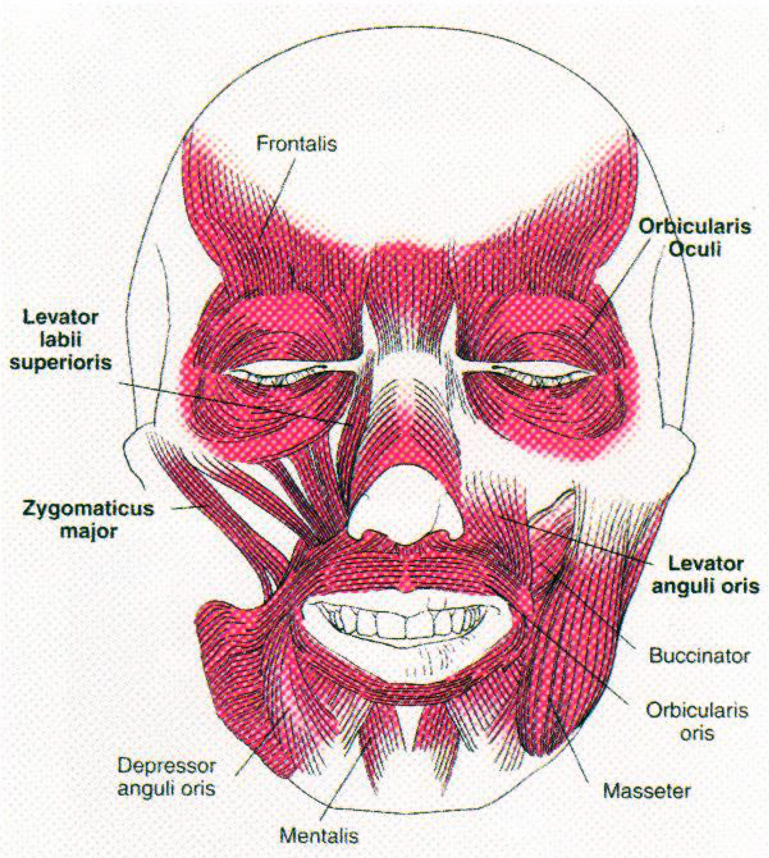

Figure 4. Primary facial muscles used in a smile.

The zygomaticus major is a slender strap muscle that arises from the malar bone anteriorly to the zygomatic suture. It descends obliquely downward and medially, inserting into the subcutaneous tissue at the angle of the mouth. This muscle serves to draw the angle of the mouth backward and upward.[5,6]

The levator labii superioris is a quadrilateral shaped muscle arising from the inferior margin of the orbit and inserting into the soft tissue of the upper lip. This is the most important muscle in elevating the upper lip, and carries it slightly forward at the same time. In addition, this muscle is primarily responsible for formation of the nasolabial ridge, which passes from the side of the nose to the angle of the mouth.[5,6]

The canine fossa is the origin of the levator anguli oris, which is a thin strap muscle that courses downward and outward to insert at the angle of the mouth, where it mingles with, among others, the fibers of the zygomaticus major. When activated, this muscle elevates the angle of the mouth and assists the levator labii superioris in forming the nasolabial ridge.[5,6]

Activation of proprioceptors in these muscles of expression as well as cutaneous receptors in the skin of the face during the act of smiling generates feedback. Impulses from these receptors are carried along the three primary branches of the trigeminal nerve (CN V): the ophthalmic, the maxillary, and the mandibular branches. These branches merge near the apex of the petrous portion of the temporal bone to form the gasserian or semilunar ganglion. The roots of the nerve then run dorsally, eventually diving directly into the lateral pons as the trigeminal nerve, and are subdivided within the pons to several different sensory and motor nuclei.[7]

The sensory input of the trigeminal nerve ascends from the pontine nuclei to the thalamus, and from thalamic axons to the sensory cortex. This sensory feedback then exerts an influence on both the premotor cortical and the motor cortical functions as a smile is initiated, carried out, and terminated.[3]

As is evident, there exists a great deal of complex neurologic and musculoskeletal interaction in the seemingly simple act of smiling. As with any other complex neuromuscular activity, repetitions of the act can train the CNS, neural network, and muscular network in efficient performance of and correct musculoskeletal activation involved in the act itself.

SMILE MUSCLE EXERCISES

It has been established in both voluntary and involuntary movements that training exercises involving repetitive activity with visual feedback lead to improved function.[8–10] Although there are no prospective trials that address this concept in relation to smiling, it is reasonable to apply these same principles to the practical application of smile training. The clinician should understand the neuroanatomic elements involved in the act of smiling as well as the foundation of learning by repetition, but the application of this process in the clinical arena is actually quite simple.

The patient should perform these exercises in front of a mirror (Figure 5). In the first step of the

Figure 5. A, The initial movement of the smile; B, half smile; C, full smile.

exercises, the corners of the mouth move slightly upward. This position should be held for 10 seconds while the patient sees and feels how the muscles move. No teeth have been exposed to this point. Next, the patient should move to a half smile. The two upper corners of the mouth move slightly more upward, the lips spread, and the cheeks move somewhat. The patient should hold this position for 10 seconds, again seeing and feeling the movement of the muscles. Finally, the patient advances to a full smile. The corners of the mouth move into the uppermost position, the lips are stretched taut, and the dentition becomes exposed. The amount of exposed dentition that constitutes a pleasing smile is determined by the personal taste and preference of the patient. This position is held for 10 seconds. The process may then be repeated in reverse.

Most patients have no difficulty in obtaining the half smile, because this represents the extent of their typical smile, since minimal teeth have been bared. The importance rests in separating each of the muscle movements, giving an awareness of muscle movement as opposed to traditional unconscious behavior. The controlled exercise uses the isotonic principle of physiotherapy by repeatedly maneuvering the entire muscle range of movement.[11]

Patients should be instructed in isometric development of the musculature of the smile as well. This involves the patient smiling in front of the mirror, then inserting the index fingers into the mouth at the angle of the mouth. Attempts are then made to return the lips to their baseline position while preventing movement with the fingers. This is held for 10 seconds, then repeated 10 times at least once per day, and should be performed in the initiation, half smile, and full smile positions (Figure 6). This maneuver aids in the development of the musculature of the smile through resistance training.[11]

As with any new learned behavior, repetition remains the key ingredient. If the patient performs these simple smile exercises in the mirror daily for even as little as 15 minutes a day, the brain and the muscles begin working together "learning" a new behavior that, with time, will become an unconscious act.

OTHER ANATOMIC DILEMMAS

The lips consist of fleshy folds surrounding the orifice of the mouth.[12] The muscles of expression act on these fleshy folds in the previously described fashion to produce the typical curvature of the lips involved in smiling, as well as to expose the teeth in full smiles. For many, however, a smile produces exposed gingiva superior to the maxillary anterior teeth, otherwise defined as a gingival smile line.[13] Commonly viewed as

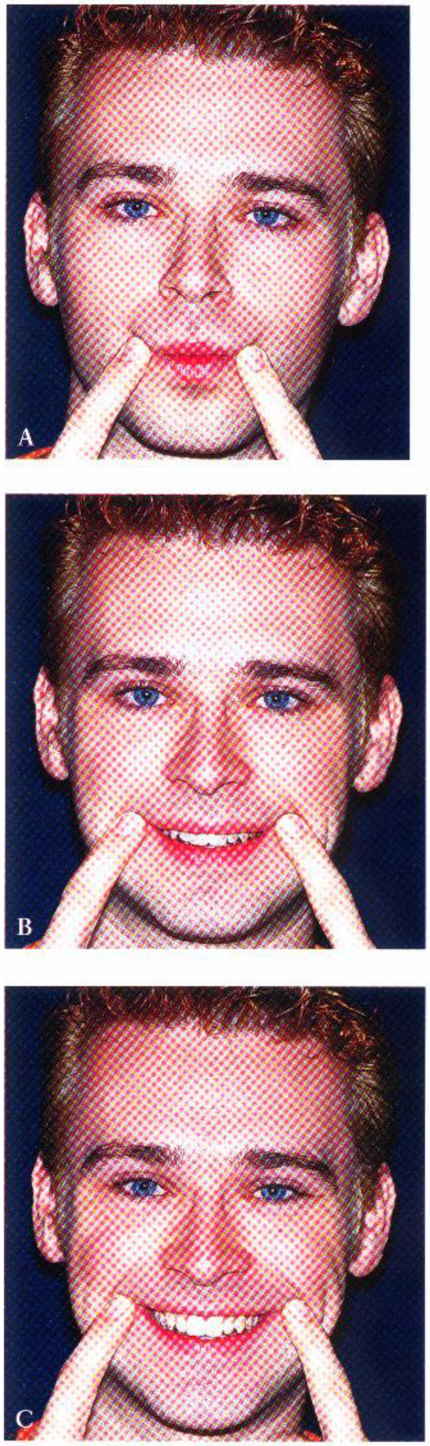

Figure 6. Steps in resistance training for development of the musculature of the smile. A, *Initiation;* B, *half smile;* C, *full smile.*

Figure 7. The undesirable "gummy smile."

undesirable, these types of smiles have been referred to as "gummy" smiles, high lip lines, short upper lips, or full denture smiles (Figure 7).[13] A plastic surgery technique may offer an alternative to orthognathic surgery. A self-curing silicon implant is injected at the anterior nasal spine in patients with gingival smile lines, resulting in a hidden subspinal mass acting to mechanically restrict upper lip elevation on smiling, thus reducing gingival display.[13]

Some evidence suggests that gingival smile lines (or the curvature of the smile line) will diminish (or degrade) with age.[13] A teenager traditionally possesses a more pronounced curvature of the lower lip than that of a 40-year-old, whose smile would be more curved or arced than that of a 76-year-old (Figure 8).[14] The sagging of the perioral soft tissue with age may occur, in part, because of the natural flattening, stretching, and decreased elasticity of skin.[13] In this context, the consultative services of a cosmetic surgeon may be beneficial in improving a patient's smile.

CONCLUSION

Instructing a patient in the performance of daily smile exercises with-

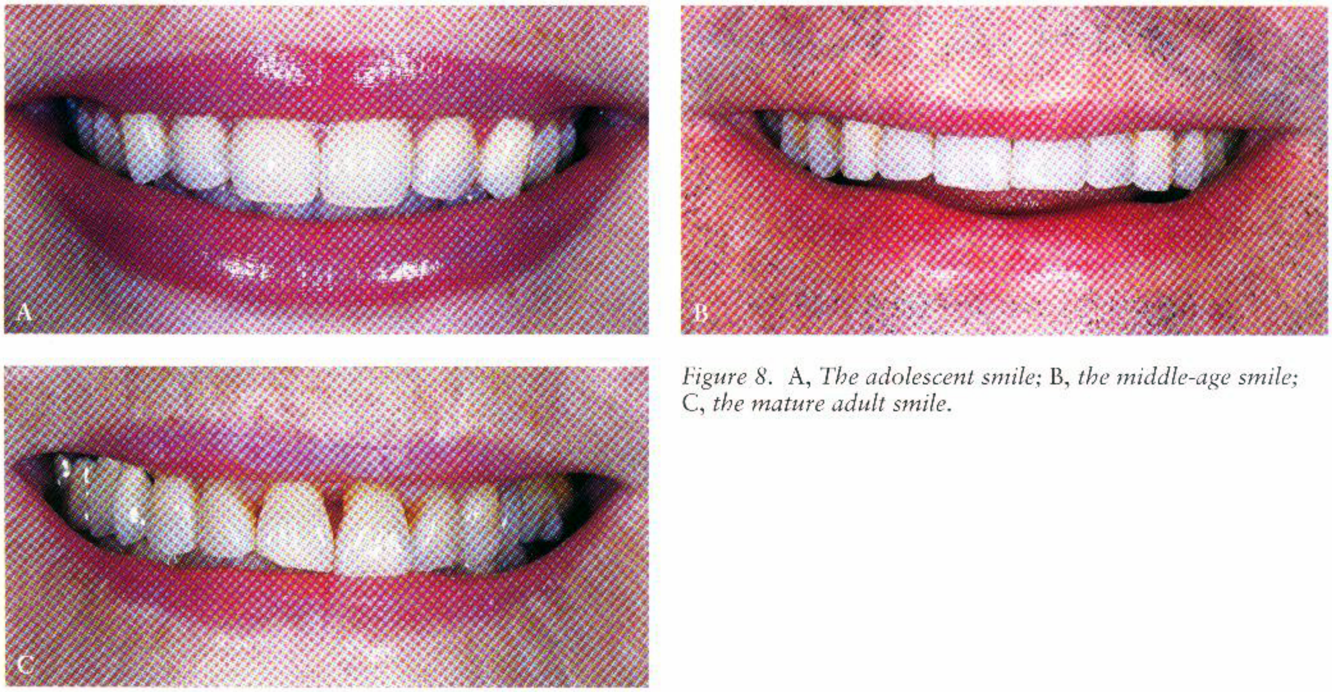

Figure 8. A, *The adolescent smile;* B, *the middle-age smile;* C, *the mature adult smile.*

out an understanding of the underlying neurologic and anatomic principles and structures as well as the concept of repetitive motion training with visual feedback represents less than optimal clinical practice. A patient needs reassurance that behind the guidance from the clinician lies medical evidence that such routine movement of muscles will indeed improve the smile. When asked why or how the exercise succeeds, the clinician can reassure the patient based on a working knowledge of the neurologic and muscular anatomy involved, as well as an understanding of basic concepts of training and feedback principles. Unfortunately, although previous literature based on repetitive exercises with visual feedback would suggest that smile training can be a valuable adjunct to dental reconstruction, no randomized prospective data currently are available to validate the hypothesis.

Physically and psychologically, a smile enhances one's outward appearance and tends to improve self-confidence and feeling of self-worth. A smile completes dental composition.[15]

When meeting or talking with a person, one's full attention focuses on the face. The esthetic dentist possesses the ability not only to bestow esthetically pleasing dentition but also to assist in the re-creation of a beautiful smile.

A smile costs nothing, but gives much. It enriches those who receive, without making poorer those who give. It takes but a moment, but the memory of it sometimes lasts forever. None is so rich or mighty that he can get along without it, and none is so poor but that he can be made rich by it. A smile creates happiness in the home, fosters good will in business, and is the countersign of friendship. It brings rest to the weary, cheer to the discouraged, sunshine to the sad, and is nature's best antidote for trouble. Yet it cannot be bought, begged, borrowed, or stolen, for it is something that is of no value to anyone until it is given away. Some people are too tired to give you a smile. Give them one of yours, as none needs a smile so much as he who has no more to give.

Believed to be
based on the writings of
Rabbi Samson Raphael Hirsch

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