

# UC Irvine

## UC Irvine Previously Published Works

### Title

Associations between psychosocial functioning and smiling intensity in patients with head and neck cancer

### Permalink

<https://escholarship.org/uc/item/6hm0d149>

### Journal

Psychology Health & Medicine, 20(4)

### ISSN

1354-8506

### Authors

Lee, Juhun  
Teo, Irene  
Guindani, Michele  
et al.

### Publication Date

2015-05-19

### DOI

10.1080/13548506.2014.951371

### Copyright Information

This work is made available under the terms of a Creative Commons Attribution License, available at  
<https://creativecommons.org/licenses/by/4.0/>

Peer reviewed

## Associations between psychosocial functioning and smiling intensity in patients with head and neck cancer

Juhun Lee<sup>a,b</sup>, Irene Teo<sup>b,c</sup>, Michele Guindani<sup>d</sup>, Gregory P. Reece<sup>b</sup>, Mia K. Markey<sup>e,f</sup> and Michelle Cororve Fingeret<sup>b,c\*</sup>

<sup>a</sup>Electrical and Computer Engineering, The University of Texas at Austin, Austin, TX, USA;

<sup>b</sup>Plastic Surgery, The University of Texas MD Anderson Cancer Center, Houston, TX, USA;

<sup>c</sup>Behavioral Science, The University of Texas MD Anderson Cancer Center, Houston, TX, USA;

<sup>d</sup>Biostatistics, The University of Texas MD Anderson Cancer Center, Houston, TX, USA;

<sup>e</sup>Biomedical Engineering, The University of Texas at Austin, Austin, TX, USA;

<sup>f</sup>Imaging Physics, The University of Texas MD Anderson Cancer Center, Houston, TX, USA

(Received 15 April 2014; accepted 29 July 2014)

Increasing attention is being given to developing quantitative measures of facial expression. This study used quantitative facial expression analysis to examine associations between smiling intensity and psychosocial functioning in patients with head and neck cancer (HNC). Smiling intensity of 95 HNC patients was measured using 48 quantitative measures calculated from facial photographs with and without a smile. We computed a composite smiling intensity score for each patient representing the degree of similarity to healthy controls. A lower composite score indicates that the person is less expressive, on average, than healthy controls. Patients also completed self-report measures assessing domains of body image and quality of life (QOL). Spearman rank correlations were computed to examine relationships between composite scores and psychosocial functioning. Composite scores were significantly correlated with multiple measures of body image and QOL. Specifically, decreased smiling intensity was associated with feelings of dissatisfaction with one's body, perceived negative social impact of body image, increased use of avoidance as a body image-coping strategy, reduced functional well-being, and greater head and neck cancer-specific issues. To the best of our knowledge, this is the first study to demonstrate associations between an objectively quantified facial expression (i.e. smiling) and psychosocial functioning. Most previous studies have measured facial expression qualitatively. These findings indicate that smiling intensity may serve as an important clinical indicator of psychosocial well-being and warrants further clinical investigation.

**Keywords:** facial expression; smiling; body image; quality of life; head and neck cancer

### Introduction

Research is increasingly devoted to developing objective quantitative measures of facial expression. For patients with trouble forming facial expressions due to facial paralysis, objective quantitative measures of facial expression have been used to evaluate medical and surgical treatments (Hontanilla & Aubá, 2008; Johnson, Bajaj-Luthra, Llull, & Johnson, 1997; Sawyer, See, & Nduka, 2010). Other work has quantified expression

---

\*Corresponding author. Email: [mcfinger@mdanderson.org](mailto:mcfinger@mdanderson.org)

differences between patients with neuropsychiatric disorders such as schizophrenia and healthy controls (Alvino et al., 2007; Verma et al., 2005; Wang et al., 2008).

Much research indicates that impaired ability to form facial expressions is related to functional limitations and decreased quality of life (QOL). For example, patients with facial paralysis who have difficulties forming facial expressions report high levels of concern (Neely & Neufeld, 1996). Moreover, problems with eating and speaking, and greater difficulties with social functioning have been demonstrated for patients with facial paralysis (Beurskens, Oosterhof, & Nijhuis-van der Sanden, 2010; Coulson, O'dwyer, Adams, & Croxson, 2004).

Patients with head and neck cancer (HNC) can also experience difficulties forming facial expressions. These patients have a high risk of experiencing changes in facial shape and structure due to the disease and/or treatment. Such changes in facial morphology can significantly impact the formation of facial expressions. Not surprisingly, these patients report high rates of body image concerns and decreased psychosocial and functional well-being (Fingeret, Vidrine, Reece, Gillenwater, & Gritz, 2010; Hagedoorn & Molleman, 2006; Millsopp et al., 2006). A particular area of clinical interest is the manner in which patients' facial smile is affected. Our goal was to utilize objective quantitative facial expression measures capturing smiling intensity and evaluate associations between these measures and self-reported psychosocial functioning for patients with HNC.

## Materials and methods

### *Datasets*

This study included 95 adult patients with HNC prior to undergoing major facial reconstructive surgery at a comprehensive cancer center. Participants were selected from a larger ongoing trial, which had recruited 99 participants to date. Four patients with difficulty posing a facial smile due to a facial tumor or nerve defect were excluded. Under an approved IRB protocol, anterior-posterior (AP) facial photographs were obtained using a Canon EOS REBEL Tli (Canon, USA). For each patient, two AP photographs were obtained; one with a peak smile (patients were asked to smile as they reflected on a time when they were extremely happy and overjoyed) and another with neutral expression.

The Binghamton University 3D facial expression database (BU-3DFE) (Yin, Wei, Sun, Wang, & Rosato, 2006) was used as a control dataset. This dataset consists of 3D facial images of 100 healthy subjects depicting seven facial expressions, including smiling, at four intensity levels, as well as a neutral expression. Subjects were mostly university students, ages 18–70. Prior research indicates age is not associated with intensity of smiling (Kunz, Mylius, Schepelmann, & Lautenbacher, 2008). We used 2D texture images of the 3D facial images from the BU-3DFE database as they provide comparable imaging data to the AP photographs in our patient dataset. The images of subjects smiling with the highest intensity and of subjects with neutral expression in the control dataset correspond, respectively, to the images of peak smile and neutral expression in our patient dataset.

### *Quantitative measures of smiling intensity*

The quantitative measures of smiling intensity consist of 48 features  $F$ , which are 24 length-normalized distances and 24 slopes based on 27 facial landmarks on the patient's facial photograph (Figure 1). Smiling intensity  $S_i$  is given as

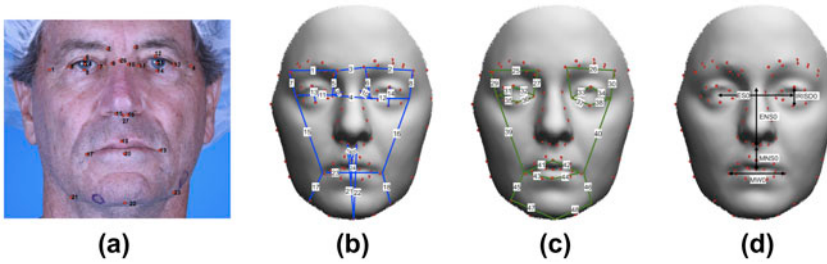


Figure 1. Quantitative measures of smiling intensity. This figure shows a total of 27 facial landmarks on the facial photograph of a patient (a), 24 distance features (b), and 24 slope features (c) obtained from those 27 facial landmarks (Tang & Huang, 2008). Twenty-four distance features were divided corresponding one of five facial animation parameter units (Pandzic & Forchheimer, 2002) by facial regions, which are eye (ES0 or IRISD0), nose (ENS0 or MNS0), and mouth (MNS0 or MW0) shown in (d).

$$S_i = F_{i,PE} - F_{i,NE}, \quad i = 1, 2, \dots, 48 \quad (1)$$

where  $i$  indexes the measure, and  $PE$  and  $NE$  refer to the peak smile and neutral expression, respectively. Further details for computing each component (i.e.  $F_i$ ) can be found elsewhere (Lee et al., 2013).

### Composite score of smiling intensity

We derived a composite score summarizing the overall degree of similarity in smiling intensity of each patient compared to that of the healthy controls:

$$\text{Score}_j = \sum_{i=1}^{48} \left| \frac{(S_i - \mu_i)}{\sigma_i} \right|^{-1}, \quad \text{for each } j\text{th patient}, \quad (2)$$

where  $\mu_i$  and  $\sigma_i$  refer to the mean and standard deviation of  $i$ th measure (i.e.  $S_i$ ) obtained from the healthy population. The parameters  $\mu_i$  and  $\sigma_i$  were computed from the BU-3DFE dataset using Equation (1). Equation (2) represents how similar a patient is to the healthy controls in terms of smiling intensity relative to the mean of the healthy controls. A lower composite score indicates that a subject is less expressive than the average healthy control.

### Self-report measures

#### Body image

Body image dissatisfaction was measured using Hopwood's Body Image Scale (BIS) (Hopwood, Fletcher, Lee, & Al Ghazal, 2001) and the Perceived Social Impact subscale of the Adapted Satisfaction With Appearance (ASWAP) scale (Heinberg et al., 2007). Body image coping, which refers to cognitive and behavioral responses to address body image challenges, was measured using the Body Image Coping Strategies Inventory (BICSI) (Cash, Santos, & Williams, 2005). The BICSI contains three subscales: appearance fixing, avoidance, and positive rational acceptance. These measures have been validated by prior research and demonstrate good internal consistencies in this study ( $\alpha$ 's range from 0.72 to 0.96).

*Quality of life (QOL)*

QOL was assessed with the Functional Assessment of Cancer Therapy-Head & Neck (FACT-HN) questionnaire (List et al., 1996), where a total score can be calculated along with five subscales: physical well-being, functional well-being, emotional well-being, social/family well-being, and HNC-specific concerns. The FACT-HN is well validated and widely used with cancer patients (D'Antonio, Zimmerman, Cella, & Long, 1996; Zabora et al., 2001).

Table 1. Patient demographic and clinical characteristics ( $N = 95$ ).

Variable/subgroup	Mean (SD)	No. of patients
<i>Age</i>	61 years (14)	
<i>Gender</i>		
Male		65
Female		30
<i>Ethnicity</i>		
Not Hispanic or Latino		91
Hispanic or Latino		4
<i>Race</i>		
White		89
Black or African American		4
Asian		1
Other		1
<i>Marital status</i>		
Married/domestic partnership		62
Divorced/separated		20
Single/never married		9
Widowed		4
<i>Disease histology</i>		
Squamous cell carcinoma		48
Melanoma		16
Basal cell carcinoma		12
Sarcoma		5
Mucoepidermoid carcinoma		4
Adenoid cystic carcinoma		4
Pleomorphic adenoma		1
Adenocarcinoma		1
Other		4
<i>Disease sites<sup>a</sup></i>		
Oral cavity		31
Mandible		13
Maxilla		15
Nose		12
Cheek		9
Ear		2
Forehead/scalp		3
Parotid		2
Oropharynx		2
Orbit		3
Chin		1
<i>BMI</i>	27.8 (5.2)	

<sup>a</sup>Frequencies may not add up to the total sample size because patients may belong to more than one subgroup.

Table 2. Spearman rank correlation coefficients and corresponding *p*-values between the composite scores and psychosocial outcomes.

Domain	Construct	Measure & subscale	Coefficient ( <i>p</i> value)	<i>p</i> -value
Body image	Body image dissatisfaction	BIS	-0.2397	0.0237*
		ASWAP – Perceived Social Impact	-0.2710	0.0098*
	Body image coping	BICSI – Appearance Fixing	-0.1319	0.2178
		BICSI – Avoidance	-0.2175	0.0406*
QOL	Physical well-being	BICSI – Positive Rational Acceptance	-0.0921	0.3934
		FACT HN – Physical Well-Being	0.1941	0.0668
	Functional well-being	FACT HN – Functional Well-Being	0.2336	0.0285*
		FACT HN – HNC Subscale	0.2238	0.0361*
	Emotional well-being	FACT HN – Emotional Well-Being	0.0857	0.4217
	Social/family support	FACT HN – Social/Family Well-Being	0.2023	0.0558
	Overall QOL	FACT HN total	0.2587	0.0149*

Note: BIS = body image scale, ASWAP = adapted satisfaction with appearance scale, BICSI = body image coping strategies inventory, FACT HN = functional assessment of cancer therapy, QOL = quality of life.

\*Statistically significant at  $p < .05$ .

### Statistical analysis

To assess associations between smiling intensity and psychosocial functioning, we conducted Spearman rank correlation analyses. Because studies have not previously examined such associations, we conducted an exploratory analysis rather than setting up a specific hypothesis. Thus, we considered the correlation coefficients to be statistically significant with respect to the traditional threshold ( $p$ -value  $< 0.05$ ) and no correction for multiple comparisons was performed. Statistical toolbox (v.7.5, R2011a) in MATLAB (The Mathworks, Natick, MA) was used.

### Results

Our patient sample has a wide range of cancers affecting the mid-face, cutaneous, and oral cavity regions (Table 1). The average composite score of smiling in our sample was 0.035 (SD = 0.082). Subscales measuring similar concepts (i.e. body image dissatisfaction, body image coping, and QOL) were grouped together. Lower composite scores, reflecting decreased smiling intensity from the average of the healthy controls, were significantly related to various psychosocial measures (Table 2). We found significant negative associations between composite scores and measures of body image dissatisfaction and body image coping: BIS ( $p = 0.0237$ ), ASWAP-Perceived Social Impact ( $p = 0.0098$ ), and BICSI-Avoidance ( $p = 0.0406$ ). Significant positive associations were found between composite scores and overall QOL as measured by the FACT-HN total score ( $p = 0.0149$ ) and for subscales related to functional well-being: FACT-HN Functional Well-Being ( $p = 0.0285$ ) and the FACT-HN Head and Neck subscale ( $p = 0.0361$ ).

### Discussion

We investigated associations between objectively quantified smiling intensity and psychosocial functioning in patients being treated for HNC. We found that decreased

smiling intensity, relative to the average of healthy controls, was associated with increased body image concerns and decreased QOL. Decreased smiling intensity was significantly correlated with dissatisfaction with one's body, discomfort in social situations, increased avoidance as a body image coping strategy, reduced functional well-being, and greater HNC-specific issues (e.g. speech and swallowing problems).

These results show, for the first time, a statistically significant linkage between objectively quantified external characteristics (i.e. smiling intensity) and self-reported measures of psychosocial functioning. Our findings complement previous literature reporting associations between positive emotional expression (e.g. amusement) and psychological well-being (Harker & Keltner, 2001). Most previous studies have measured facial expression qualitatively utilizing Facial Action Coding System (Ekman & Friesen, 1978), which requires human inputs. Our proposed method can potentially reduce human bias/error by using quantitative distances between facial fiducial points.

We provide evidence that smiling intensity is associated with body image and functional well-being for patients with HNC. Body image is a critical psychosocial issue for HNC patients, and is recognized to extend beyond how one views his/her physical appearance to include how one perceives, thinks, and feels about his/her entire body and its functioning (Fingeret et al., 2010). Our findings show, the degree to which patients produce a maximum smile is associated with appearance satisfaction and the degree to which they engage in avoidant behaviors related to their appearance. Further, we found significant associations between smiling intensity and perceived functional well-being for HNC patients prior to undergoing major reconstructive surgery where significant changes to facial morphology were anticipated but had not yet occurred.

These findings should be further evaluated with healthy populations and other clinical populations where the ability to form facial expressions is compromised. Particular consideration should be given to evaluating changes in formation of facial expression over time for patients undergoing medical treatment and how such changes contribute to psychosocial functioning. One potential clinical application of our findings is that compromised smiling intensity may serve as a rough marker for body image/psychosocial distress when psychosocial assessments are not administered but routine photographs are available.

A primary limitation of this study involves its cross-sectional design. We were therefore only able to evaluate associations. Future work is needed to consider whether there are any causal links between impairment in facial expressions and psychosocial functioning.

## References

- Alvino, C., Kohler, C., Barrett, F., Gur, R.E., Gur, R.C., & Verma, R. (2007). Computerized measurement of facial expression of emotions in schizophrenia. *Journal of Neuroscience Methods*, 163, 350–361. doi:[10.1016/j.jneumeth.2007.03.002](https://doi.org/10.1016/j.jneumeth.2007.03.002)
- Beurskens, C.H.G., Oosterhof, J., & Nijhuis-van der Sanden, M.W.G. (2010). Frequency and location of synkineses in patients with peripheral facial nerve paresis. *Otology & Neurotology*, 31, 671–675. doi:[10.1097/MAO.0b013e3181d8d84d](https://doi.org/10.1097/MAO.0b013e3181d8d84d)
- Cash, T.F., Santos, M.T., & Williams, E.F. (2005). Coping with body-image threats and challenges: Validation of the body image coping strategies inventory. *Journal of Psychosomatic Research*, 58, 190–199. doi:[10.1016/j.jpsychores.2004.07.008](https://doi.org/10.1016/j.jpsychores.2004.07.008)
- Coulson, S.E., O'dwyer, N.J., Adams, R.D., & Croxson, G.R. (2004). Expression of emotion and quality of life after facial nerve paralysis. *Otology & Neurotology*, 25, 1014–1019. doi:[10.1097/00129492-200411000-00026](https://doi.org/10.1097/00129492-200411000-00026)

- D'Antonio, L.L., Zimmerman, G.J., Cella, D.F., & Long, S.A. (1996). Quality of life and functional status measures in patients with head and neck cancer. *Archives of Otolaryngology – Head & Neck Surgery*, 122, 482–487.
- Ekman, P., & Friesen, W.V. (1978). *Facial action coding system: A technique for the measurement of facial movement*. Palo Alto: Consulting Psychologists Press.
- Fingeret, M.C., Vidrine, D.J., Reece, G.P., Gillenwater, A.M., & Gritz, E.R. (2010). Multidimensional analysis of body image concerns among newly diagnosed patients with oral cavity cancer. *Head & Neck*, 32, 301–309. doi:10.1002/hed.21181
- Hagedoorn, M., & Molleman, E. (2006). Facial disfigurement in patients with head and neck cancer: The role of social self-efficacy. *Health Psychology*, 25, 643–647. doi:10.1037/0278-6133.25.5.643
- Harker, L., & Keltner, D. (2001). Expressions of positive emotion in women's college yearbook pictures and their relationship to personality and life outcomes across adulthood. *Journal of Personality and Social Psychology*, 80, 112–124. doi:10.1037/0022-3514.80.1.112
- Heinberg, L.J., Kudel, I., White, B., Kwan, A., Medley, K., Wigley, F., & Haythornthwaite, J. (2007). Assessing body image in patients with systemic sclerosis (Scleroderma): Validation of the adapted satisfaction with appearance scale. *Body Image*, 4, 79–86. doi:10.1016/j.bodyim.2006.11.002
- Hontanilla, B., & Aubá, C. (2008). Automatic three-dimensional quantitative analysis for evaluation of facial movement. *Journal of Plastic, Reconstructive & Aesthetic Surgery*, 61, 18–30. doi:10.1016/j.bjps.2007.03.037
- Hopwood, P., Fletcher, I., Lee, A., & Al Ghazal, S. (2001). A body image scale for use with cancer patients. *European Journal of Cancer*, 37, 189–197.
- Johnson, P.J., Bajaj-Luthra, A., Llull, R., & Johnson, P.C. (1997). Quantitative facial motion analysis after functional free muscle reanimation procedures. *Plastic and Reconstructive Surgery*, 100, 1710–1719.
- Kunz, M., Mylius, V., Schepelmann, K., & Lautenbacher, S. (2008). Impact of age on the facial expression of pain. *Journal of Psychosomatic Research*, 64, 311–318. doi:10.1016/j.jpsychores.2007.09.010
- Lee, J., Fingeret, M.C., Teo, I., Hanasono, M.M., Skoracki, S.J., & Markey, M.K. (2013). Quantitative measures of facial expression for patients with head and neck cancer. In *Engineering in Medicine and Biology Society (EMBC), 2013 Annual International Conference of the IEEE* (pp. 3706–3709). Osaka: IEEE.
- List, M.A., D'Antonio, L.L., Cella, D.F., Siston, A., Mumby, P., Haraf, D., & Vokes, E. (1996). The performance status scale for head and neck cancer patients and the functional assessment of cancer therapy-head and neck scale. A study of utility and validity. *Cancer*, 77, 2294–2301. doi:10.1002/(SICI)1097-0142(19960601)77:11<2294:AID-CNCR17>3.0.CO;2-S
- Millsopp, L., Brandom, L., Humphris, G., Lowe, D., Stat, C., & Rogers, S. (2006). Facial appearance after operations for oral and oropharyngeal cancer: A comparison of casenotes and patient-completed questionnaire. *The British Journal of Oral & Maxillofacial Surgery*, 44, 358–363. doi:10.1016/j.bjoms.2005.07.017
- Neely, J.G., & Neufeld, P.S. (1996). Defining functional limitation, disability, and societal limitations in patients with facial paresis: Initial pilot questionnaire. *The American Journal of Otolaryngology*, 17, 340–342.
- Pandzic, I.S., & Forchheimer, R. (2002). *MPEG-4 facial animation: The standard, implementation, and applications*. Hoboken, NJ: Wiley.
- Sawyer, A.R., See, M., & Nduka, C. (2010). Quantitative analysis of normal smile with 3D stereophotogrammetry – An aid to facial reanimation. *Journal of Plastic, Reconstructive & Aesthetic Surgery*, 63, 65–72. doi:10.1016/j.bjps.2008.08.062
- Tang, H. & Huang, T.S. (2008). 3D facial expression recognition based on properties of line segments connecting facial feature points. In *Automatic Face & Gesture Recognition, 2008. FG'08. 8th IEEE International Conference* (pp. 1–6). Amsterdam: IEEE.
- Verma, R., Davatzikos, C., Loughhead, J., Indersmitten, T., Hu, R., Kohler, C., ... Gur, R.C. (2005). Quantification of facial expressions using high-dimensional shape transformations. *Journal of Neuroscience Methods*, 141, 61–73. doi:10.1016/j.jneumeth.2004.05.016
- Wang, P., Barrett, F., Martin, E., Milonova, M., Gur, R.E., Gur, R.C., ... Verma, R. (2008). Automated video-based facial expression analysis of neuropsychiatric disorders. *Journal of Neuroscience Methods*, 168, 224–238. doi:10.1016/j.jneumeth.2007.09.030



- Yin, L., Wei, X., Sun, Y., Wang, J., & Rosato, M.J. (2006). A 3D facial expression database for facial behavior research. In *7th International Conference on Automatic Face and Gesture Recognition, 2006 FGR 2006* (pp. 211–216). Southampton, UK. doi:[10.1109/FGR.2006.6](https://doi.org/10.1109/FGR.2006.6)
- Zabora, J., BrintzenhofeSzoc, K., Jacobsen, P., Curbow, B., Piantadosi, S., Hooker, C., ... Derogatis, L. (2001). A new psychosocial screening instrument for use with cancer patients. *Psychosomatics*, 42, 241–246. doi:[10.1176/appi.psy.42.3.241](https://doi.org/10.1176/appi.psy.42.3.241)