Lipid components. Tfayli et al. (2012b) studied the skin of 20 volunteers aged 22 to 64 years old. Overall, a lower total amount of lipids was detected in the skin of the elderly volunteers. In order to specify lipid markers of aging, they analyzed "subtracted" skin spectra, that is, the difference between normal skin spectra and spectra for skin from which the lipid components had been extracted through rubbing of the skin with an alcohol mixture. A principal component analysis on the 2845 to 3020 cm^{-1} region of the subtracted spectra yielded good discrimination between three groups: the younger population, the elderly population, and a "middle-aged" group. Hence, the 2845 to 3020 cm^{-1} region is a significant marker of aging in SC. Additional analysis showed the relative intensity of the 2850 to 2960 cm^{-1} region to be higher for younger SC lipids, indicating small changes in the lateral packing. Within this spectral region, the authors point out the decrease in relative intensity of the 2930 cm^{-1} peak as relating to a decrease in intermolecular and organizational order in the elderly skin. Therefore, this peak could be a marker of the weaker barrier function of elderly skin. Another marker of age is the ratio of intensities I_{2880}/I_{2845}, which was lower in aged skin. This points to a lower amount of *trans* conformers *gauche* conformation in the alkyl chain of the lipids of aged skin.

Corroborating Tfayli et al.'s (2012b) results, Boireau-Adamezyk et al. (2014) observed a significant decrease in the lipid-to-protein ratio in the dorsal and volar forearm of volunteers with increasing age. Differences between the two sides of the forearms were only significant in their oldest subpopulation (55 to 70 years of age). Analyzing the fingerprint region of Raman spectra, they found the ratio *trans*/*gauche* lipid conformation ($I_{1055–1070} + I_{1120–1140}/I_{1080–1090}$) to decrease significantly with age only on the dorsal (sun-exposed) forearm. Again only the oldest subpopulation presented differences in this ratio between the two sides of the forearm. They showed that SC ceramide content decreases with age only on the forearm site. Cholesterol content decreases with age on face and the dorsal forearm, not the volar forearm. Unlike SC thickness, which is a function of chronological aging, their results indicated that SC lipid content and conformation are functions of extrinsic (e.g., photo-) aging.

In accordance with previous results on lipid content, Binder et al. (2017) showed lower ceramide and cholesterol relative intensities as a function of depth in the skin of volunteers more than 50 years old compared to those less than 25 years old.

Choe et al. (2018a) analyzed the effect of age on SC lipid spectral markers in both the fingerprint and the high wavenumber region. The ratio of intensities indicative of lateral packing order according to C–H vibrations (a modification of the I_{2880}/I_{2845} ratio used by Tfayli et al. (2012b) is greater in elderly skin within the top 20% to 30% of the SC thickness. The ratio $I_{1080}/(I_{1130} + I_{1060})$, indicating the relative amount of *gauche* to *trans* conformation according to the skeleton C-C vibration, was significantly lower in elderly skin at depths corresponding to 30% to 40% of the SC thickness. Thus, elderly SC has prevalence of *trans* conformation and therefore higher-ordered packing at those depths. However, they did not find a significant difference in the ratio $(I_{2850} + I_{2880})/I_{2930}$ representative of the mean amount of lipid normalized to the keratin present in SC.

Protein conformation. Choe et al. (2018a) also focused on the spectral intensities centered around 2390 cm^{-1}, indicative of folding or unfolding properties of keratin filaments. This marker did not reveal a significant difference in the studied populations.

55.4.2.6 Effects of Water/Moisturizer Exposure and Environmental Humidity on Skin Components

Water and NMF. The permeability of skin for hydrophilic molecules increases dramatically with skin hydration. Hydration by occlusion or exposition to high humidity level results in an increase of the SC water content from 13% (standard value) to near 400% of the dry tissue weight (Williams and Barry 2004). Water in SC can be either bound to structural elements (NMF, functional groups) or free. The free water acts as a solvent for hydrophilic molecules in the SC, thus increasing the solubility of drugs in the tissue. Drug partition between the cosmetic product and the SC is then