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The flavor of the color and the texture of the shape: Effects of visual aspects on expectation and perception of chocolates

O sabor da cor e a textura do formato: Efeitos de aspectos visuais na expectativa e percepção de chocolates

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Orientador: Prof. Dr. Jorge Herman Behrens

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ABSTRACT

Food tasting is a multisensory experience that involves all human senses, including vision. Visual aspects contribute to the experience of eating and drinking by drawing attention, expressing identity, communicating qualities, eliciting emotions and influencing both expectations and perceptions of taste, aroma, texture and liking. This study performed three experiments on the effects of chocolate shape and packaging. The first experiment compared the expectations (pre-tasting) and perceptions (post-tasting) of chocolates in two shapes, one rounded and one squared. The second experiment evaluated the effects of seven packaging colors on expectations of milk and dark chocolates among Brazilian and French consumers. Analysis of variance showed that the chocolate shape significantly ($p<.05$) influenced the expectation and the perception of creaminess, while the packaging color influenced the expected sweetness, bitterness, fruitiness, melting and liking. It was also shown that the colors had similar effects among French and Brazilian consumers, that the cold/warm classification of colors did not entirely explain the effects, and that the effect of a given packaging color on liking is inverted for milk and dark chocolates. To expand the findings, a third experiment analyzed the effects and interactions of four visual variables (color, facetype, illustrated ingredient, chocolate shape) of milk chocolate packaging on consumer expectations by means of a choice-based conjoint experiment. Mixed logit model evidenced that the color of the packaging is the main factor on taste, aroma and preference expectations, and that the chocolate shape was mostly correlated with texture. A word association task revealed that consumers associated the pink packaging with “strawberry” and “childish” and the black packaging with “bitterness” and “cocoa”. The results also indicate the possibility of measuring crossmodal effects using choice-based tasks. These findings are useful for chocolate manufacturers and packaging designers, and contributes to the research on food consumption as a multisensory experience.

Keywords
Sensory evaluation, chocolate, consumers, packaging, expectation.

RESUMO

A degustação de alimentos é uma experiência multissensorial capaz de envolver todos os sentidos humanos, inclusive a visão. Os aspectos visuais contribuem para a experiência de comer e beber ao chamar atenção, expressar identidade, comunicar qualidades, provocar emoções e também influenciar as expectativas e percepções de gostos, aromas, textura, preferência e aceitação. Este trabalho realizou três experimentos sobre os efeitos do formato e das embalagens de chocolates. O primeiro experimento comparou as expectativas (pré-degustação) e percepções (pós-degustação) de consumidores para chocolates em dois formatos, um redondo e outro quadrado. O segundo experimento avaliou os efeitos de sete cores de embalagens nas expectativas de consumidores brasileiros e franceses. Análises de variância mostraram que o formato do chocolate influenciou a expectativa e a percepção de cremosidade, e que a cor da embalagem influenciou as expectativas de doçura, amargor, frutado, derretimento e aceitação de chocolates. Também mostraram que as cores geraram efeitos parecidos em consumidores franceses e brasileiros, que a divisão das cores em quentes e frias não explica completamente os efeitos, e que o efeito de uma dada cor sobre a expectativa de aceitação é inversa no leite e no amargo. Para expandir as descobertas, um terceiro experimento analisou os efeitos e interações de quatro variáveis visuais (cor, fonte tipográfica, ingrediente ilustrado, formato do chocolate) em embalagens de chocolate ao leite na preferência e expectativas de consumidores brasileiros. Modelos logísticos mistos reforçaram que a cor da embalagem é o principal fator nas expectativas de gostos, sabores e preferência, e que o formato do chocolate é o aspecto visual mais relacionado à cremosidade. Em uma tarefa de associação de palavras, os consumidores associaram embalagens rosas aos termos “morango” e “infantil”, e embalagens pretas aos termos “amargo” e “cacau”. Os resultados também indicam ser possível medir efeitos *crossmodais* por meio de análise conjunta de tarefa baseada em escolha. Essa tese contribui com o conhecimento científico sobre os efeitos de aspectos visuais no consumo multissensorial de alimentos e oferece informações úteis a fabricantes e designers de embalagens de chocolate.

Palavras-chaves
Avaliação sensorial, chocolate, consumidor, embalagens, expectativas.

SUMÁRIO

INTRODUÇÃO

O consumo de alimentos é uma experiência multissensorial que mobiliza todos os cinco sentidos – visão, olfato, paladar, tato e audição –, além de envolver a memória e processos cognitivos (SPENCE, 2017). Embora nem sempre os consumidores percebam conscientemente, a visão participa do consumo de alimentos de diversas formas, do primeiro contato com um produto em um anúncio publicitário até o descarte da embalagem, sendo talvez o sentido mais importante na escolha e no uso de produtos (SCHIFFERSTEIN, 2006). O que os consumidores veem numa comida ou bebida pode influenciar sua preferência, atenção, percepção de preço, qualidade, sustentabilidade, saudabilidade e também expectativas (pré-consumo) e percepções (pós-consumo) de gostos, aromas, textura e aceitação (CARDELLO, 2007; VELASCO & SPENCE, 2019a).

Quando aspectos percebidos por um sentido, como a visão, são relacionados espontaneamente por uma larga parte de um grupo ou população a aspectos de outros sentidos, como gostos, aromas e texturas, chama-se de correspondência *crossmodal*. Exemplos são associações entre a cor preta e o gosto amargo (WAN et al., 2014), formatos arredondados e texturas cremosas (ARES & DELIZA, 2010), e a cor amarela e o aroma amanteigado (HEATHERLY et al., 2019). Sugere-se que as correspondências *crossmodais* possam ser explicadas por *predictive coding* (PIQUERAS-FISZMAN & SPENCE, 2015) ou *sensory cue integration* (PARISE, 2016), modelos que propõem que o cérebro funciona por inferência (CLARK, 2013), ou seja, a memória de experiências anteriores participa da percepção dos estímulos sensoriais para economizar tempo e energia.

As correspondências *crossmodais* podem se tornar efeitos *crossmodais* quando um sentido influencia a expectativa e/ou percepção de outro sentido (SPENCE, 2011), por exemplo, quando a cor da embalagem altera a percepção da cremosidade de uma bebida láctea (TIJSSEN et al., 2017). O efeito da expectativa na percepção pode ser compreendido a partir da teoria da assimilação-contraste (ANDERSON, 1973): se a percepção for próxima à expectativa, a tendência é que as pessoas assimilem a expectativa à avaliação do produto; por outro lado, se a diferença é grande demais para ser assimilada, ocorre o inverso, por contraste, as pessoas exacerbam a diferença entre expectativa e percepção.

Dentre os aspectos visuais, a cor ou a combinação de cores é possivelmente o mais importante (SINGH, 2006), seja a cor dos alimentos em si (SPENCE, 2019), a cor externa da embalagem (SPENCE, 2018), do interior da embalagem (VAN ESCH, 2019), do recipiente (PIQUERAS-FISZMAN et al., 2012) e do ambiente (OBERFELD et al., 2009; CHO et al., 2015). Cores podem ser caracterizadas em termos de matiz (a frequência de ondas, a cor propriamente dita), brilho (quanto preto ou branco é adicionado à matiz) e saturação (intensidade da matiz) (SPENCE & VELASCO, 2018). Em geral, os estudos associam os efeitos com a divisão entre cores quentes (comprimento de ondas longos, como vermelho e amarelo) e frias (comprimento de ondas curtos, como verde e azul) (HUANG & LU, 2015).

Em relação às correlações entre formatos, palavras e gostos, há consenso na literatura quanto às formas arredondadas, o gosto doce e as palavras bouba/maluma/lula estarem associadas assim como as formas angulares, as palavras kiki/takete/tuki e os gostos amargo e ácido serem comumente relacionados entre si (SPENCE & NGO, 2012; SPENCE et al., 2013; VELASCO et al., 2014; SALGADO-MONTEJO et al., 2015, VELASCO et al., 2016b). No primeiro grupo, ainda se pode acrescentar maior aceitação hedônica e simetria, bem como menor aceitação e assimetria ao segundo grupo (VELASCO et al., 2015; VELASCO et al., 2016a, TUROMAN et al., 2018). Além disso, as relações valem também para combinações, por exemplo, um círculo e um quadrado representarem o agridoce (VELASCO et al., 2018).

Assim, as embalagens passam a ser entendidas como ferramentas de comunicação que chamam atenção, expressam identidade, aumentam ou diminuem o apetite, alteram sentimentos, transmitem mensagens ao consumidor alvo e influenciam expectativa e percepção das características sensoriais do produto (CARDELLO, 2007; VELASCO & SPENCE, 2019a). Embora a compreensão da importância das embalagens possa parecer intuitiva nos dias atuais, é preciso lembrar que até a primeira metade do século XX as embalagens, se utilizadas, eram primariamente ferramentas de proteção física, química e biológica para comidas e bebidas (HINE, 1995). Somente com o surgimento dos supermercados no Ocidente e o declínio dos armazéns e feiras que elas passaram a ser o meio de comunicação e venda de produtos, colocando-as no centro das atenções de marqueteiros,

designers e cientistas do comportamento do consumidor (VELASCO & SPENCE, 2019a).

Dentro de todo esse contexto, o objetivo geral desta tese foi avaliar os efeitos de aspectos visuais de chocolates e suas embalagens na expectativa (pré-consumo) e percepção (pós-consumo) de gostos, aromas, textura, preferência e aceitação de chocolates por consumidores. O chocolate foi escolhido por assumir diversos formatos de barras e bombons sem causar estranhamento e, geralmente, ser consumido diretamente da embalagem no formato original, aumentando a possibilidade de influencia dos aspectos visuais na sua expectativa e percepção (SPENCE & VELASCO, 2019a). Além disso, também foi escolhido por ser um produto geralmente consumido com motivação exclusivamente hedônica e com processo de escolha de compra pouco racionalizado e independente de vendedores.

Para atender ao objetivo geral, foram realizados três experimentos com diferentes objetivos específicos. O primeiro experimento analisou os efeitos de formatos redondo e quadrado na expectativa e percepção de doçura, amargor, cremosidade e aceitação em chocolates ao leite e amargo em consumidores brasileiros. O segundo experimento analisou os efeitos de sete cores de embalagem nas expectativas de consumidores brasileiros e franceses para doçura, amargor, frutado, derretimento e aceitação de dois chocolates, um ao leite e outro amargo. A partir dos resultados do primeiro e segundo experimento, um terceiro experimento foi desenhado para analisar conjuntamente os efeitos de quatro variáveis visuais (cor de embalagem, fonte tipográfica, ingrediente ilustrado e formato do chocolate ilustrado) em embalagens de chocolate ao leite.

Cada um desses três experimentos resultou em um artigo científico e cada artigo é reproduzido nessa tese como um capítulo. Como elementos introdutórios aos três artigos/capítulos, há essa introdução e uma revisão de literatura. Nessa última são revisadas: a história, a tipificação, o processo de fabricação e a importância do chocolate no Brasil e no mundo; a análise sensorial; a análise conjunta; a associação de palavras; as teorias que tratam dos efeitos da expectativa em consumidores; o entendimento sobre correspondências e efeitos *crossmodais*; as pesquisas publicadas sobre os efeitos da cor da embalagem de alimentos; e sobre os efeitos de formatos intrínsecos e contextuais no consumo de alimentos.

Após essa revisão de literatura, seguem os três artigos/capítulos principais da tese, uma discussão geral que articula os três experimentos como um conjunto e, por fim, breves considerações finais. Como os três artigos são reproduzidos integralmente como capítulos aqui, cada um possui sua lista de referências própria em seu fim, enquanto que as referências bibliográficas mencionadas na Introdução e Discussão geral estão após as Considerações finais. Nos anexos dessa tese, estão o parecer consubstanciado do Comitê de Ética em Pesquisa da Unicamp, as permissões de reprodução dos artigos já publicados, o comprovante de submissão do terceiro artigo e os questionários utilizados nos experimentos.

CAPÍTULO 1 - REVISÃO BIBLIOGRÁFICA

1.1 Chocolate

Os olmecas provavelmente foram os primeiros a cultivar cacaueiros (*Theobroma cacao*), na região que hoje é o sudeste do México. Os maias teriam aprendido o plantio com os olmecas por volta de 600 a.C. e posteriormente passaram a vender as amêndoas para os astecas, cuja região mais ao norte é fria e árida demais para a árvore. Os astecas torravam, moíam e misturavam o cacau com baunilha, pimenta, flores aromáticas, mel e água para preparar uma bebida considerada estimulante, afrodisíaca e restrita aos nobres (MCGEE, 2010).

Os espanhóis levaram o cacau para a Europa na volta da quarta expedição à América, em 1502, e, em 1580, a bebida com açúcar e baunilha já era vendida em estabelecimentos na França, Inglaterra e Itália. Com o intuito de criar uma bebida mais leve, o holandês Conrad van Houten inventou um método para separar a gordura dos sólidos de cacau em 1828. Descartando a manteiga de cacau e utilizando somente o cacau em pó, a bebida mantinha boa parte do sabor característico e não pesava tanto no estômago (MCGEE, 2010).

Descobre-se, em seguida, que a massa de cacau, antes raramente consumida sólida, ficava com textura e sabor agradáveis quando adicionada de sua manteiga. Surge o chocolate. A primeira fábrica de chocolates, Fry & Sons, abriu em 1847 na Inglaterra. Em 1876, o suíço Daniel Peter usa o leite em pó recém-inventado por seu compatriota Henri Nestlé para criar o chocolate ao leite. Dois anos depois, Rudolf Lindt inventa a concha, uma máquina que mistura e refina as partículas, contribuindo significativamente para as características físicas, químicas e sensoriais do chocolate como ele é conhecido hoje (MCGEE, 2010). O processo contemporâneo de produção de chocolate pode ser esquematizado conforme a **Figura 1**.

O cacaueiro, cujo nome científico *Theobroma* significa "alimento dos deuses”, é cultivado em uma faixa de 20° acima e abaixo do equador. A árvore pode chegar a sete metros de altura e produzir frutos alongados que chegam a 25 cm de comprimento e 10 cm de diâmetro, embora esses números variem bastante entre as variedades da espécie. Cada fruto tem 20 a 40 sementes envoltas em uma polpa branca adocicada e protegida por uma espessa carne fibrosa. As sementes

são ricas em gordura para nutrir o desenvolvimento do gérmen e essa reserva energética é protegida do interesse de predadores por compostos alcaloides amargos e fenóis adstringentes (MCGEE, 2010).

Figura 1 - Fluxograma do processo de produção de chocolate.

Uma vez colhidos os frutos, retira-se as sementes e a polpa da parte fibrosa para que fermentem na própria fazenda de cultivo. Primeiramente, leveduras consomem os açúcares da polpa e produzem álcool, conforme o oxigênio que estava incorporado na mistura acaba, bactérias lácticas passam a se proliferar. Em seguida, as sementes são constantemente reviradas para oxigenar e a fermentação passar para a fase acética. Sem fermentar, o chocolate resultante fica mais amargo, adstringente e frutado, porque a acidez do vinagre rompe a semente, deixando

entrar oxigênio e aromas da polpa fermentada, além de liberar enzimas digestivas que simplificam açúcares e proteínas (BECKETT, 1994).

Assim como a fermentação, a secagem é usualmente realizada no local de plantio. Embora possa ser feita em secadores a gás, lenha ou eletricidade, usualmente são apenas espalhadas ao sol. Ela diminui a umidade, interrompendo e evitando a retomada de processos químicos e biológicos. Depois de secas, as amêndoas são transportadas para o processamento, que normalmente ocorre em uma fábrica fora do local de cultivo, muitas vezes em outros países, principalmente União Europeia e Estados Unidos, que não cultivam cacau, mas são os maiores consumidores de seus produtos (MCGEE, 2010).

A temperatura e tempo de torra são variáveis importantes para a determinação das características do produto final, pois reduz a acidez e estimula a reação de Maillard entre açúcares redutores e aminoácidos liberados na fermentação. De forma geral, chocolates industriais têm uma torra mais escura que chocolates artesanais “grão à barra”, pois a sobretorra padroniza sabor e oculta defeitos do cacau. Uma vez torradas, as amêndoas são descascadas por sopro e trituradas em pequenos pedaços chamados nibs. Os nibs são moídos em uma pasta arenosa e quebradiça chamada líquor ou massa de cacau (BECKETT, 1994).

Para produção de chocolate, a massa de cacau é refinada e/ou conchada sozinha ou com outros ingredientes como açúcar, manteiga de cacau, sólidos de leite, aromatizantes, aditivos e outros. Enquanto o refino é o processo de diminuir o tamanho das partículas, a conchagem concomitantemente aquece, refina e mistura os ingredientes. Nela, diversos processos físicos e químicos ocorrem, desenvolvendo por completo o sabor e textura do produto final ao promover a reação de Maillard, emulsificar as partículas hidrofóbicas na fase hidrofílica, volatilizar até 80% dos compostos voláteis e diminuir a acidez e umidade (MCGEE, 2010; BECKETT, 1994).

Em seguida, o chocolate deve ser temperado, ou seja, ser resfriado controladamente para que a cristalização ocorra privilegiando a formação de cristais nas formas beta V e VI. Como as moléculas da gordura de cacau são relativamente simples, elas são polimórficas, ou seja, podem assumir diferentes formas de cristalização. A beta V é a mais desejável por ser compacta e não perpendicular às pontas, resultando em um chocolate mais estável e com melhores características

sensoriais de aparência e textura. Assim que temperado, o chocolate deve ser moldado, resfriado, desmoldado e embalado (BECKETT, 1994).

O mundo consumiu 7,3 milhões de toneladas de chocolate em 2016, representando US$98,2 bilhões em vendas. A Europa Ocidental foi responsável por US$34,4 bilhões desse mercado e os Estados Unidos da América (EUA) por US$22,4 bilhões (CONWAY, 2018). Para atender essa demanda, a colheita de cacau quadruplicou de pouco mais de 1 milhão de toneladas no início dos anos 1960 para 4,3 milhões em 2016. Embora seja costume citar Rozin et al. (1991) como evidência de que o chocolate é um dos alimentos mais desejados pelos ocidentais, é melhor indício disso que, nos EUA, país que mais consome esse produto, o volume de vendas de confeitos com chocolate seja o dobro da soma de todos os outros confeitos (GAILLE, 2019).

No Brasil, a colheita de cacau foi de 198 mil toneladas, rendendo 1,88 bilhão de dólares aos produtores em 2018 (RAMOS, 2019). Já o faturamento com a fabricação de chocolate foi de R$13,3 bilhões, sendo 94,8% vendido para o mercado interno e apenas 5,2% exportado. Cerca de 75% dos brasileiros declaram comer o doce ao menos uma vez a cada três meses e 35% afirmam que não o trocam por outro alimento e/ou bebida (SEBRAE, 2018). Resultados de Fonseca et al. (2019) indicam que a preferência e sentimentos relacionados ao chocolate estão significativamente relacionados à classe social.

Em termos legais, a Resolução da Diretoria Colegiada (RDC) 264/2005 (ANVISA, 2005) determina que o chocolate é um produto alimentício obtido a partir da mistura de derivados de cacau e outros ingredientes. Sem especificar outros atributos ou categorias, a RDC postula que chocolate deve ter ao menos 25% de sólidos de cacau e chocolate branco deve ter 20%. Em comparação (Tabela 1), os EUA exigem 10% de massa de cacau no chocolate ao leite e a União Europeia 25% no chocolate ao leite e 20% no chocolate ao leite “familiar” (FDA, 2019; FAO, 2003).

Se por um lado o chocolate é um alimento de alto valor calórico, rico em gordura e açúcar, por outro ele é fonte de minerais dietéticos - como ferro, cobre, magnésio, zinco, fósforo - e flavonóides antioxidantes e antiinflamatórios (SEEM et al., 2019). Essas características fazem seu consumo frequente ser relacionado tanto à obesidade e ao aumento de triglicerídios e colesterol séricos (VERONESE et al., 2019), quanto à diminuição de níveis de estresse, genotoxicidade celular,

osteoporose e pressão arterial, bem como à melhora da sensibilidade à insulina, da capilaridade sanguínea cerebral e do metabolismos lipídico e glicolítico (GRASSI et al., 2015; SOKOLOV et al., 2013; REES et al., 2018).

Tabela 1 - Total de sólidos de cacau exigidos pelos regulamentos do Brasil, Estados Unidos da América e União Europeia em % do peso total do chocolate (ANVISA, 2005; FDA, 2019; FAO, 2003).

Total de sólidos de cacau exigidos			
	Brasil	**EUA**	**UE**
Chocolate	25%	-	35%
Chocolate meio amargo	-	35%	-
Chocolate "doce"	-	15%	30%
Chocolate ao leite	-	10%	25%
Chocolate ao leite "familiar"	-	-	20%
Chocolate branco	20%	20%	20%

Uma vez que a presença dos compostos bioativos benéficos à saúde humana é diretamente proporcional à concentração de cacau (VINSON et al., 1999), torna-se de interesse público aumentar a proporção desse ingrediente nos chocolates consumidos pela população. Porém, a resposta psicoativa e a quantidade ingerida por consumidores tendem a aumentar diretamente proporcionais à concentração de açúcar adicionado na formulação (CASPERSON, 2019). Assim, torna-se um desafio incrementar a quantidade de compostos bioativos através do aumento da proporção de cacau sem que haja perda de aceitabilidade.

O presente projeto de pesquisa aborda o tema pelo viés do formato do chocolate e da cor da embalagem na expectativa e percepção desse confeito. Algumas características do produto e de seu consumo o tornam ideal para esse viés, tais como: a facilidade técnica de moldar o chocolate; a venda e consumo habitualmente diretos no formato e na embalagem de fabricação; a inexistência de um formato ou cor de embalagem usualmente associados; o consumo mundial três vezes maior do ao leite em relação ao amargo (CONWAY, 2016), havendo sentido em desenvolver estratégias que elevem o percentual de cacau usualmente aceito pelos consumidores.

1.2 Análise sensorial

A análise sensorial de alimentos é uma disciplina científica relativamente nova, pois se consolidou a partir da segunda metade do século XX, e compreende

“um conjunto de técnicas para medir com precisão as respostas humanas a alimentos” (LAWLESS & HEYMANN, 1998, p.01). Embora o nome enfoque apenas uma das ações, esse campo de pesquisa evoca, mede, analisa e interpreta a influência de propriedades específicas e isoladas na percepção visual, auditiva, tátil, gustativa e olfativa de alimentos (LAWLESS & HEYMANN, 1998). Assim, a análise sensorial fornece informações estratégicas para cientistas, desenvolvedores e produtores da área.

As abordagens da análise sensorial são tradicionalmente categorizadas em três classes: discriminativas, descritivas e afetivas. De início, os estudos descritivos eram usualmente realizados por avaliadores treinados e os afetivos por consumidores, porém avaliações descritivas e qualitativas feitas por consumidores têm ganhado cada vez mais validação e novas metodologias para atender aos inúmeros desdobramentos das demandas e perguntas de pesquisa. Assim, historicamente, a análise sensorial com consumidores deixa de ser focada apenas em respostas hedônicas para abordar como e por que os consumidores gostam e preferem os produtos que gostam e preferem (VARELA & ARES, 2018).

1.3 Análise conjunta

Desde que surgiu como um modelo matemático para ordenação de preferência na década de 1960, o conceito de *análise conjunta* mudou e se fragmentou ao longo das décadas. Hoje, pode ser considerado um um nome genérico para experimentos de preferência declarada em que consumidores escolhem entre produtos com combinações de fatores. A abordagem mais comum é a holística, em que participantes são estimulados por produtos ou representações de produtos com diferentes combinações de tratamentos para um determinado número de variáveis. (ALMLI & NÆS, 2018).

Como exemplo, pesquisadores interessados em entender melhor as preferências do consumidor de café gelado na Noruega podem analisar a importância de fatores como preço, tipo de café, origem do produto e quantidade de calorias (ASIOLI et al., 2016). Uma forma de fazer isso, é medir a preferência dos consumidores por cada um dos tratamentos isolando as variáveis, preferem café puro ou com leite, italiano ou norueguês, que custa 17 ou 29 coroas, com 60 ou 90 calorias? Outra forma é medir a preferência com todas as variáveis combinadas, o

que eles preferem entre um café puro italiano com 60 calorias por 17 coroas e um café com leite norueguês com 90 calorias por 29 coroas?

Ao juntar todas as variáveis em um único experimento, a análise conjunta se aproxima mais de uma situação real de consumo e possibilita a mensuração de interações entre os tratamentos. No caso do café gelado, os pesquisadores poderiam descobrir, por exemplo, que os consumidores noruegueses preferem cafés mais baratos, mas estão mais dispostos a pagar um pouco mais quando é italiano. E como eles incluíram os valores, é possível calcular exatamente quantas coroas a mais eles estão dispostos a pagar por um café importado. Eles também poderiam ter descoberto que os participantes preferem cafés com menos calorias quando for puro, mas com mais calorias se for ao leite.

Os cálculos de quanto cada característica vale em relação a outras são previstas pela teoria da utilidade randômica (RUT, na sigla em inglês). A RUT propõe que os consumidores têm uma “utilidade”, ou um preço (nem sempre monetário), para cada tratamento de cada atributo e que assim é possível comparar diretamente a utilidade de variáveis independentes entre si (ALMLI & NÆS, 2018). No exemplo dos cafés gelados, seria possível calcular quão mais importante é o produto ser italiano em relação a ser menos calórico, ou quantas coroas a mais os noruegueses estariam dispostos a pagar para cada caloria a menos que o café tenha.

1.4 Associação de palavras

No início do século XX, Carl Gustav Jung criou o “teste de associação de palavras” para ajudar no diagnóstico e tratamento de desordens de personalidade em sua clínica de psicologia. Em poucos anos, pesquisas em marketing e comportamento dos consumidores incorporaram a técnica como uma ferramenta simples e eficiente para superar barreiras de comunicação, aflorar pensamentos e atitudes inconscientes. Na tarefa de associação de palavras, os participantes são estimulados com uma palavra, uma frase, uma marca, uma imagem ou um produto e são pedidos a falar ou escrever a primeira ou primeiras palavras que vierem à mente (Mesías & Escribano, 2017).

A associação de palavras é uma técnica projetiva de pesquisa com humanos, portanto, parte de um estímulo ambíguo ou pouco estruturado para acessar crenças, desejos e vontades dos participantes. A ausência de estrutura nas

respostas ajuda a ocultar o objetivo da pesquisa e permite que os participantes atribuam livremente significados aos estímulos, fazendo da associação de palavras uma técnica qualitativa. Enfim, como não há respostas certas ou erradas em pesquisas projetivas, elas são consideradas capazes de aflorar pensamentos e atitudes inconscientes, assim como respostas vergonhosas ou socialmente inaceitáveis (Mesías & Escribano, 2017).

1.5 Expectativa

Um dos fenômenos estudados pela análise sensorial é a expectativa de consumidores e painelistas ao consumir ou avaliar um produto, pois quando o produto é consumido, ele é automaticamente confrontado com a expectativa que gerou. Teorias explanatórias descrevem quatro principais fenômenos decorrentes de uma expectativa não correspondida (CARDELLO, 2007). Primeiro, pode ocorrer assimilação, ou seja, a percepção é ajustada à expectativa, o consumidor percebe aquilo que esperava. Segundo, um contraste, quando a desconfirmação leva a uma exacerbação da diferença, fazendo a percepção se distanciar ainda mais da expectativa. Terceiro, há a teoria da negatividade generalizada, em que qualquer desconfirmação leva à avaliação negativa. Por fim, a teoria da assimilação-contraste prevê que caso o desempenho de um produto fique próximo do esperado, há assimilação; se o desempenho ficar distante, ocorre contraste (ANDERSON, 1974).

Na sua vertente clássica, a análise sensorial busca eliminar ou controlar ao máximo as expectativas para evitar esses efeitos que seriam considerados vieses na percepção e na avaliação das amostras estudadas (DELIZA, 2017). Porém, o consumo de alimentos está sempre em um contexto e o contexto sempre gera expectativas. Participam do contexto fatores extrínsecos multissensoriais como os sons e barulhos do ambiente, os utensílios utilizados, os termos usados para descrevê-los, a opinião de outras pessoas sobre o produto, as embalagens, o preço, assim como fatores subjetivos de quem come, como suas preferências, seu estado emotional, seus processos cognitivos e suas memórias de experiências anteriores direta ou indiretamente relacionadas ao evento (PIQUERAS-FISZMAN & SPENCE, 2015; SCHIFFERSTEIN, 1996).

Assim, a análise sensorial passa a desconsiderar o modelo tradicional de expectativa como viés e busca investigar seus mecanismos, efeitos e importâncias.

Em revisão, Rosires Deliza (2017) identifica dois tipos de expectativas, as sensoriais e as hedônicas. As primeiras são relativas às características sensoriais do produto alimentício (como seus gostos, sabores, texturas) e as segundas são relativas à intensidade do gostar ou desgostar. Armand Cardello (2007) explica que embora as empresas costumem saber o que os consumidores esperam sensorial e hedonicamente de um produto alimentício, mais raramente elas dominam as expectativas que os fatores extrínsecos de seus produtos provocam, tornando pesquisas sobre esses fatores fundamentais.

1.6 Crossmodalidade

Dentre as expectativas criadas pelos fatores extrínsecos de um alimento, estão as correspondências *crossmodais*, correlações aparentemente arbitrárias entre qualidades de sentidos distintos, como um som e um gosto ou uma cor um sabor (SPENCE, 2011). Diferente dos efeitos do condicionamento descrito por Pavlov (1927) e da sinestesia, as relações *crossmodais* são consistentes e repetitivas entre amplos grupos de pessoas, às vezes de contextos muito distintos (BREMNER et al., 2013), sem treinamento específico. Ela também chama atenção por ser bidirecional - as relações são válidas em ambas as direções - tanto mostrando uma cor e pedindo para relacionar a um gosto, quanto o inverso (SPENCE et al., 2015).

Neste trabalho, faz-se uma diferenciação entre correspondência e efeitos *crossmodais*, enquanto as primeiras são apenas correlações, os segundos são eventos em que um estímulo afeta outro. Ou seja, quando uma população apenas relaciona um formato arredondado com a textura cremosa, ou relaciona a cor preta com o gosto amargo, são correspondências (WAN et al., 2014). Por outro lado, se o formato ou cor de uma embalagem fizer essa população esperar (pré-consumo) (MATTHEWS et al., 2019; REBOLLAR et al., 2017; SOUSA et al., 2020a) ou perceber (pós-consumo) (PIQUERAS-FISZMAN et al., 2012; SUGIMORI & KAWASAKI, 2022) o produto mais doce, mais ácido ou mais amargo, tratam-se de efeitos, pois o atributo de sentido está afetando, alterando, interferindo no atributo de outro sentido.

Sugere-se que as interações *crossmodais* possam ser explicadas por *predictive coding* (PIQUERAS-FISZMAN & SPENCE, 2015) ou *sensory cue*

integration (PARISE, 2016), modelos que propõem que o cérebro funciona por inferência (CLARK, 2013), ou seja, a memória de experiências anteriores participa da percepção dos estímulos sensoriais para economizar tempo e energia. Essas inferências podem ter natureza estrutural (inata), estatística (aprendizado por observação de padrão), semântica/linguística (palavras remetem a sensações); heurísticas (processos mentais inconscientes), afetivas (despertam sentimentos e são relacionados por eles) ou uma combinação delas (SPENCE et al., 2015; VELASCO et al., 2016a; TUROMAN et al., 2018).

Os efeitos *crossmodais* na percepção podem ter natureza comportamental (influencia na resposta dada) ou perceptível (influencia na recepção e/ou processamento do próprio estímulo) ou uma combinação de ambas. Estudos com ressonância magnética evidenciam se tratar da segunda opção (WOODS et al., 2011), mostrando que a expectativa gerada por estímulos visuais, olfativos e informações altera a ativação das áreas cerebrais relativas ao processamento das informações sensoriais gustativas (PIQUERAS-FISZMAN & SPENCE, 2015).

1.7 Cor da embalagem

A embalagem participa das relações *crossmodais* porque, além de proteger o produto física, química e microbiologicamente, serve de ferramenta de comunicação ao chamar atenção, criar identidade visual, aumentar ou diminuir apetite, alterar sentimentos e transmitir mensagens quanto ao sabor do produto ou seu posicionamento de mercado (KRISHNA et al., 2017; SPENCE & VELASCO, 2018; KOVAČ et al., 2019). No geral, a visão é provavelmente o sentido mais importante no uso de produtos (SCHIFFERSTEIN, 2006) e a cor ou a combinação de cores possivelmente o aspecto isolado mais importante de uma embalagem (SINGH, 2006). Ela pode ser caracterizada em termos de matiz (a cor propriamente dita), brilho (quanto preto e/ou branco é adicionado à matiz) e saturação (intensidade da matiz) (SPENCE & VELASCO, 2018).

Spence & Velasco (2018) e Zellner et al. (2018) apontam que a cor vermelha pode indicar diferentes coisas dependendo do produto, como integralidade em leites (no Brasil, em geral significa ser desnatado, enquanto que o azul representa ser integral), apimentado em temperos prontos, salgado em batatas fritas (no Brasil, margarinas usam tampa vermelha para indicar a adição de sal), frutas

vermelhas em sobremesas, recheio de carne bovina em congelados ou sabor cola em refrigerantes. Esses casos deixam claro que a interpretação da cor não é fixa, depende do produto, da cultura e da intenção atribuída ao fabricante pelo consumidor.

Mesmo quando não funcionam como sinais intencionais de determinadas características ou ingredientes, a cor da embalagem influencia de forma consistente e estatisticamente relevante a expectativa que diferentes grupos de consumidores têm em relação a um produto. Fatores como nível de atenção dado a estímulos imagéticos de comida (BRIGNELL et al., 2009; HUANG & LU, 2015), frequência do consumo (LICK et al., 2017), idade (PIQUERAS-FISZMAN et al., 2011) e, claro, contexto cultural (SHANKAR et al., 2010) demonstraram modular as correlações existentes.

Foi encontrado nenhum estudo avaliando especificamente o efeito da cor da embalagem de chocolates, porém sabe-se que a cor dos alimentos em si (SPENCE, 2019), a cor externa da embalagem (PIQUERAS-FISZMAN & SPENCE, 2015; SPENCE, 2018), do interior da embalagem (VAN ESCH, 2019), do recipiente (PIQUERAS-FISZMAN et al., 2012) e do ambiente (OBERFELD et al., 2009; CHO et al., 2015) afetam a percepção do consumidor quanto à intensidade dos atributos do alimento, sua identidade, qualidade, potencial de saciedade, propriedades hedônicas, emoções provocadas (MERLO et al, 2018) e também sua quantidade consumida até a saciedade.

Um dos primeiros trabalhos sobre o tema testou embalagens de suco de maracujá em consumidores que não conheciam o produto (DELIZA, 1996 apud DELIZA & MACFIE, 2001). A cor da caixa (laranja ou branca) influenciou principalmente a expectativa de doçura e acidez, mas também aceitação, frescor, refrescância, pureza e percepção de naturalidade. Posteriormente, Ares & Deliza (2010) publicaram um trabalho com sobremesas lácteas em potes brancos ou pretos. Para os consumidores uruguaios, a cor amarela remeteu a doce de leite e a cor preta a refinamento.

Puyares et al. (2010) encontraram o formato e cor de garrafa ideais para um vinho tinto, algo parecido com o que fizeram depois Lunardo e Livat (2016) para o formato e cor do rótulo de um vinho rosé. Piqueras-Fiszman & Spence (2011) relataram que a cor da embalagem de batata chips influencia na identificação do

sabor, mas não na aceitação. Já Rebollar et al. (2012) testaram embalagens de goma de mascar em diferentes cores e formatos com consumidores online e reportaram que as cores são relevantes na expectativa de sabor, gosto e aceitação dos produtos. Huang & Lu (2015) manipularam digitalmente a cor de embalagens de cereal matinal, sorvete, chá gelado e iogurte para vermelho, verde e azul, descobrindo que a primeira gera consistentemente a expectativa de um produto mais doce e menos saudável.

A saturação das cores também alterou as expectativas geradas por embalagens vermelhas ou azuis de linguiça light e iogurte com menos açúcar (TIJSSEN et al., 2017). O iogurte foi esperado e percebido mais doce, cremoso e intenso em embalagem vermelha. A linguiça foi esperada, mas não percebida, mais gorda e de sabor mais intenso na vermelha. A ausência de alteração significativa na percepção poderia ser oriunda da distância entre a embalagem e o consumo da linguiça, ou seja, não se come direto da embalagem (SCHIFFERSTEIN et al., 2013). O brilho teve efeitos inversos entre os dois produtos, sendo que mais brilho diminuiu a expectativa de doçura no iogurte e aumentou a expectativa de sabor na linguiça.

Zellner et al. (2018) também não encontraram diferença significativa na percepção de balas em embalagens de cores diferentes, embora sejam colocadas na boca diretamente da embalagem e tenham gerado expectativas diferentes. A possível causa para a ausência de alteração na percepção é que as balas eram insossas demais por serem apenas açúcar puxado. De acordo com a teoria da assimilação-contraste (ANDERSON, 1973), a interação entre expectativa e percepção pode resultar em assimilação ou contraste. Se a percepção for próxima à expectativa, a tendência é que o cérebro aproxime a percepção da expectativa; por outro lado, se a diferença é grande demais para ser assimilada, ocorre o inverso, por contraste, as pessoas exacerbam a diferença entre expectativa e percepção.

Em revisão, Spence (2018) enumera ao menos duas generalizações encontradas entre três ou mais estudos: sobremesas parecerem mais doces em pratos brancos (PIQUERAS-FISZMAN et al., 2012, PIQUERAS-FISZMAN et al., 2013, STEWART & GOSS, 2013) e a cor vermelha reduz ou faz preterir o consumo de alimentos considerados menos saudáveis (GENSCHOW et al., 2012; BRUNO et al., 2013; REUTNER et al., 2015). Outra correlação que parece ser universal é o aumento da saturação e o aumento da expectativa de intensidade de sabor, com

exceção reportada em um dos dois experimentos de Tijssen et al. (2017). Porém, como normalmente os experimentos foram realizados em situações controladas em que apenas a cor das embalagens varia, não necessariamente os resultados se repetiriam em um contexto real, em que há vários estímulos simultâneos.

1.8 Formato

Em relação aos formatos, há consenso na literatura quanto às interações *crossmodais* entre eles, palavras e gostos: formas arredondadas, gosto doce e as palavras bouba/maluma/lula estão relacionadas assim como formas angulares, as palavras kiki/takete/tuki e os gostos amargo e ácido (SPENCE & NGO, 2012; SPENCE et al., 2013; VELASCO et al., 2014; SALGADO-MONTEJO et al., 2015, VELASCO et al., 2016b). No primeiro grupo, ainda se pode acrescentar melhor aceitação hedônica e simetria, bem como pior aceitação e assimetria ao segundo grupo (VELASCO et al., 2015; VELASCO et al., 2016a, TUROMAN et al., 2018). Além disso, as correlações valem também para combinações como um círculo e um quadrado representarem o gosto agridoce (VELASCO et al., 2018).

Aplicando a produtos, encontra-se que embalagens de sobremesas lácteas redondas geram expectativa de maior aceitação e quantidade consumida, assim como expectativa de um produto mais doce, líquido, infantil e calórico que embalagens quadradas (ARES & DELIZA, 2010). Na outra direção, três tipos diferentes de cervejas foram correlacionados com formas 2D e 3D, havendo associação de: doçura com objetos volumosos, redondos e regulares; amargor e carbonatação com objetos angulares e de pontas difusas; e, em menor significância, acidez com figuras finas (DEROY & VALENTIN, 2011).

As correlações *crossmodais* também parecem válidas para chocolates. Um coberto com caramelo e outro ao leite foram associados a figuras arredondadas, sentimento agradável e as palavras "lula", "maluma" e "bouba"; já chocolates amargos, mentolados ou maltados foram associados a figuras pontiagudas, sentimento desagradável e/ou as palavras "tuki", "takete" e "kiki" (NGO & SPENCE, 2011; BREMNER et al., 2013; SPENCE & GALLACE, 2011). Estudos de marketing buscaram tornar a comunicação das embalagens de chocolate mais eficiente (WESTERMAN et al., 2012; SCHÜTTE, 2013; SHEKHAR & RAVEENDRAN, 2013),

encontrando correlações entre formatos, aceitação e qualidades mais abstratas como "moderno", "clássico", "infantil", "esportivo", "qualidade".

Pesquisas avaliando a capacidade de estímulos visuais influenciarem a percepção são mais recentes. Primeiro, Liang et al. (2013) relataram ser possível alterar a percepção de intensidade de doçura em soluções de açúcar por meio de estímulos visuais mostrados imediatamente antes da degustação. O efeito é muito claro na concentração 3,1 g/L, mas não nas 1,5 ou 3,9 g/L. A diminuição da percepção de dulçor ao ver uma estrela antes de provar a solução 3,1 g/L é mais significativa que o aumento gerado por formatos redondos (LIANG et al., 2013). Recentemente, servindo bebida láctea sabor morango e bebida cafeinada à base de mate em recipientes transparentes angular ou redondo, Machiels (2018) encontrou efeito significativo apenas no aumento da percepção de amargor do mate quando consumido no recipiente cúbico.

Em pesquisa com dez formatos diferentes de chocolate, Lefant et al. (2013) encontrou efeitos significativos em derretimento, homogeneidade, granulosidade, sabor de cacau, caramelo e sabor residual. Gostos (doçura, acidez e amargor) não foram influenciados. Outra pesquisa posterior (WANG et al., 2017) também não relatou diferença na intensidade percebida de doçura, amargor e cremosidade entre chocolates amargos (71% e 80% cacau) redondos e angulares, embora o formato tenha influenciado significativamente na expectativa desses atributos. Dessa forma, as amostras quadradas foram percebidas como mais doces e menos agradáveis do que o esperado, e os chocolates redondos, como menos doces, mais amargos, menos cremosos e menos agradáveis que o esperado.

Os resultados de Wang et al. (2017) e Machiels (2018), assim como os de Zellner et al. (2018) mencionados no item anterior, podem ser compreendidos sob a luz da teoria da assimilação-contraste (ANDERSON, 1973). Se a bebida láctea estava muito mais doce que o esperado, ao invés de ocorrer a assimilação da expectativa na percepção, houve contraste. O mesmo pode ter ocorrido com os chocolates 71% e 80% de cacau se eles eram muito amargos e poucos ou nada doces, tornando necessário um estudo que analise o efeito do formato em chocolates com diferentes intensidades de amargor e dulçor.

CAPÍTULO 2 – THE SHAPE OF CREAMINESS

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The shape of creaminess: consumers expected and perceived rounded chocolates as creamier than squared

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Abstract

Purpose

Research on cross-modal sensory interactions has shown that visual aspects of food can influence consumer's expectation and perception of taste, mouthfeel, and liking. This work investigated the effects of a rounded ("bouba") and a squared ("kiki") shape on expected and perceived sweetness, bitterness, creaminess, and liking of chocolates.

Design/methodology/approach

Brazilian consumers (N = 230) divided into two groups of 115 individuals each evaluated five chocolates containing 30%, 40%, 50%, 60%, and 70% of cocoa. One of the groups evaluated all formulations in the rounded shape and the other in the squared shape. Results were analysed with mixed-MANOVA between shapes, repeated-measures MANOVA between pre- and post-tasting, and Pearson's correlation analysis was performed between liking ratings and sweetness, bitterness, and creaminess confirmation/disconfirmation.

Findings

The study found significant effects ($p < 0.05$) of shape on expected and perceived creaminess, but not on other attributes; of cocoa percentage (30%, 40%, 50%, 60% and 70%) on all four attributes; and time (pre- and post-tasting) on sweetness, bitterness, and liking, but not creaminess. Finally, it found significant negative correlations between the creaminess difference indices and the liking ratings for the 30%, 50%, and 60% chocolates.

Originality

This study reports that consumers may expect and perceive chocolates as creamier in a rounded shape than in an angular shape, and that if the expectation of creaminess is not confirmed by sensory perception, acceptability may be negatively affected.

Keywords

Consumer perception; Cross-modality; Mouthfeel; Taste; Chocolate.

2.1 Introduction

When Cadbury changed the rectangular shape of its Dairy Milk chocolate bar to a rounded one in 2013, some consumers complained that the product tasted sweeter than it used to be, but the company claimed that the formulation was not changed. More than a curious story, events like this show how visual aspects of food (e.g. colour, shape, volume, surface texture) may influence expectation and perception of features from other sensory modalities, such as taste, touch or smell (Spence, 2013). These non-arbitrary associations between stimuli from different sensory modalities are known as ‘cross-modal correspondences’ and are fundamental to the development of products because of their influence on consumer’s experience (Velasco *et al*., 2016; Deroy and Spence, 2016).

One of the most iconic cross-modal associations, although its cross-modal nature is questioned by Cuskley *et al.* (2017), was recorded anecdotally almost a hundred years ago by Köhler (1929). He assumed that people would easily relate a curvy figure with the non-word “baluma” and a spiky figure with the non-word “takete”. The hypothesis was later confirmed by Holland and Wertheimer (1964) and the phenomenon became known as the “bouba and kiki effect” after Ramachandran and

Hubbard (2001) alleged without reporting an experiment that 95% of people assign the non-words and figures as expected. Maurer *et al.* (2006) later confirmed the association of the non-words “bouba” with a rounded shape and “kiki” with an angular shape among adults and toddlers.

On food, the bouba and kiki effect was tested for products and beverages (Spence and Gallace, 2011; Gallace *et al.*, 2011; Deroy and Valentin, 2011; Bremner *et al.*, 2013; Ngo *et al.*, 2013; Spence *et al.*, 2013), tastes (Cytowic and Wood, 1982; Simner *et al.*, 2010; Velasco *et al.*, 2014; Wan *et al.*, 2014; Wan *et al.*, 2015; Turoman *et al.*, 2018; Velasco *et al.*, 2018), aromas (Hanson-Vaux *et al.*, 2013; Metatla *et al.*, 2019), dish presentation (Fairhurst *et al.*, 2015), and mouth sensations (Gil-Pérez *et al.*, 2019; Winter *et al.*, 2019; Hanada, 2020). Two groups of associations were well established: one between rounded shapes, sweetness, liking, symmetry, and the non-words bouba/maluma/squid; and another between angular shapes with bitterness, sourness, disliking, asymmetry, and the non-words kiki/takete/tuki (Spence and Ngo, 2012; Velasco *et al.*, 2015a; Velasco *et al*., 2016).

Further research evaluated the bouba and kiki effect on consumer expectation and perception of food and beverages through the packaging (Becker *et al.*, 2011), plate (Piqueras-Fiszman *et al.*, 2012; Fairhurst *et al*., 2015; Chen *et al.*, 2018), figure and word (Liang *et al.*, 2013), latté art (van Doorn *et al.*, 2015), glass (for a review and discussion on whether effects are physical or psychological: Spence and Wan, 2015), typeface (Velasco *et al.*, 2015b; Sousa *et al.*, 2020b), cup pattern (van Rompay *et al.*, 2017), cup (Machiels, 2018; Carvalho and Spence, 2018), product (Spence *et al.*, 2019) or a mix of elements (Velasco *et al*., 2014; Sousa *et al.*, 2020a; Motoki and Velasco, 2021).

Particularly on chocolate, a mint fondant milk chocolate and a caramel covered in milk chocolate were associated with a rounded shape, pleasantness, the non-words “maluma” and “lula”. On the other hand, a mint solid dark chocolate and a malt honeycomb covered in dark chocolate were associated with an angular shape, the non-words “takete” and “tuki” (Ngo *et al.*, 2011a; Ngo and Spence, 2011b; Spence and Gallace, 2011). Curiously, it was reported (Bremner *et al*., 2013) that Himba people in Namibia associated inversely the same milk and dark chocolates used by Ngo *et al*. (2011a) with rounded or angular shapes. Other studies have also found correlations between assorted shapes of chocolate with acceptance and

broader concepts such as "modern", "classic", "kids", "sports", "quality", etc. (Westerman *et al.*, 2012; Schütte, 2013; Shekhar and Raveendran, 2013).

Following, research was conducted to assess if the shape could influence expectation and perception of taste, mouthfeel, and liking in chocolate. Tasting a 70% cocoa chocolate in ten shapes designed for different melting rates, a trained panel of 12 women in lab booths in Switzerland reported significant effects on melting, homogeneity, granularity, cocoa flavour, caramel flavour, and residual flavour, but not on sweet, sour or bitter tastes alone (Lenfant *et al.*, 2013). As the aim of their study was to evaluate the influence of shape on melting rates, and not through cross-modal visual cues, the samples were designed according to biometric criteria and described by monadic profiling and time intensity tests.

Another study carried out with 102 visitors of a museum in Belgium (Wang *et al.*, 2017) investigated the effect of a rounded and an angular shape on sweetness, bitterness, creaminess, and linking of dark chocolates with 71% or 80% cocoa content. The authors reported that shape significantly influenced the expectations (pre-tasting) for the three first attributes, but not the perception (post-tasting) of any of the attributes assessed. Identical or very similar chocolates were used in another experiment (Carvalho *et al.*, 2017) with 116 visitors of the same museum in Belgium, again without effects of shape on post-tasting ratings of the same attributes.

As previous studies have shown that sensory expectations are able to influence sensory perception and hedonic judgment of food products (Piqueras-Fiszman and Spence, 2015), Wang *et al*. (2017) argued that the mismatch between pre and post-tasting of the rounded chocolate (i.e. it was perceived significantly more bitter, less sweet, creamy and liked than expected) might have prevented the expectation to be assimilated and made it be contrasted, as predicted by the assimilation-contrast theory (Cardello and Sawyer, 1992). A confounding factor might have been the reflection of light on the surface of the rounded shape, making it look brighter than the angular chocolate with its flat top. Wang *et al*. (2017) also suggested that the asymmetry in their angular sample and the symmetry in their rounded sample might have been a confounding factor, as symmetry is related to the bouba and kiki effect as well (Salgado-Montejo *et al*., 2015; Turoman *et al*., 2018).

In this context, the present study investigates whether the shape of the product affects consumer's expectation and perception of sweetness, bitterness, creaminess, and liking of four milk chocolates (30%, 40%, 50%, and 60% cocoa) and one dark chocolate (70% cocoa). While the attributes and scales are similar to the ones used by Wang *et al*. (2017), the chocolates (ranging from 30% to 70% cocoa vs. 71% and 80% cocoa), the shapes (symmetrical 'square' and 'circle' both with flat tops vs. asymmetrical 'cube' and symmetrical semi-sphere), the participants (community of a Brazilian university vs. visitants of a Belgian museum) and the design (within- vs. between-participants) are different.

As both chocolates tested by Wang *et al*. (2017) had high cocoa content, they might have been too bitter to cause an assimilation effect (Sheriff *et al.*, 1958), causing either contrast when expected to be somewhat sweet or confirmation when expected to be not sweet at all. Thus, this study chose to test a range of five formulations of decreasing sweetness and increasing bitterness. Then, both the rounded and the squared shapes chosen for this test are symmetrical and have flat tops to avoid different light reflection. Finally, the between-participants design was chosen over the within-participants despite being more conservative and less powerful (Charness *et al*., 2012) because it is more similar to real context. Except for some assorted chocolate boxes, consumers are usually exposed to only one shape when eating chocolate.

It is important to note that the word "creaminess" assumes multiple meanings depending on consumers and products (Tournier *et al*., 2007), being related to sensations as different as smooth, thick, liquid, greasy, easy, delight, and soft (Antmann *et al*., 2011). Still, this descriptor was chosen for being used in similar experiments before (Wang *et al*., 2017; Carvalho *et al*., 2017) and being commonly used as an attribute for chocolate by consumers (Thamke *et al*., 2009). In Brazil, creaminess might even be more common, as consumers usually chew chocolates instead of letting them melt in mouth, in part because most of the chocolates sold in the country have low cocoa content, non-cocoa fat, emulsifiers, and stabilizers to endure climate conditions and to cheapen the product (Sebrae, 2018). Moreover, a halo-dumping effect (Clark and Lawless, 1994) is likely to happen, with all mouthfeel characteristics influencing the consumer rating of creaminess.

The hypotheses of the present study are:

H1 The rounded chocolates will be expected (pre-tasting) to be sweeter (**H1a**), less bitter (**H1b**), creamier (**H1c**), and more liked (**H1d**) than the squared chocolates.

H2 The rounded chocolates will be perceived (post-tasting) as sweeter (**H2a**), less bitter (**H2b**), creamier (**H2c**), and more liked (**H2d)** than the squared chocolates.

H3 Shape effect will be weaker on chocolates at the extremes of bitterness/sweetness intensity scale (30% and 70% cocoa) and stronger on middle range chocolates (40%, 50%, 60%).

H4 Liking ratings will be influenced by the match or mismatch between the expected and actual sensory experience, given the assimilation-contrast theory.

2.2 Methods

2.2.1 Chocolate manufacturing

The chocolate samples were made with cocoa mass and deodorised cocoa butter (Barry Callebaut, Itabuna, Brazil), icing sugar (União, Araras, Brazil), whole milk powder (Italac, Três Corações, Brazil), and soy lecithin (Grings, São João da Boa Vista, Brazil). Five different formulations (**Table I**) of chocolate were artisanally made at the University of Campinas (UNICAMP) accordingly to the method and equipment described by Soto *et al*. (2020), except for the tempering and molding.

Table 1. Formulations of the chocolate samples: ingredients are expressed in percentage of total weight.

	30% Cocoa	**40% Cocoa**	**50% Cocoa**	**60% Cocoa**	**70% Cocoa**
Sugar	54,5	48,5	42,5	36,5	29,5
Cocoa Butter	10	12	14	16	18
Cocoa Mass	20	28	36	44	52
Powder Milk	15	11	7	3	0
Lecithin	0,5	0,5	0,5	0,5	0,5

The formulations were tempered to a temper index of 5.0 ± 1.0 measured by a ChocoMeter (Aasted, Farum, Denmark). Each mass was warmed to 40°C, then cooled at a rate of 2°C per minute until it reached 28°C (70% and 60% cocoa), 27,5°C (50% cocoa), 27°C (40% cocoa) or 26,5°C (30% cocoa) and was kept in this

condition for 10 minutes. After that, the temperature was raised to 31°C for 5 minutes and the chocolate was poured in acrylic molds (BWB Embalagens, Mogi Guaçu, Brasil) in two different shapes (**Figure 1**). Chocolates were wrapped in foil and stored in a fridge (2-4°C) for two weeks until the day before the sensory evaluation.

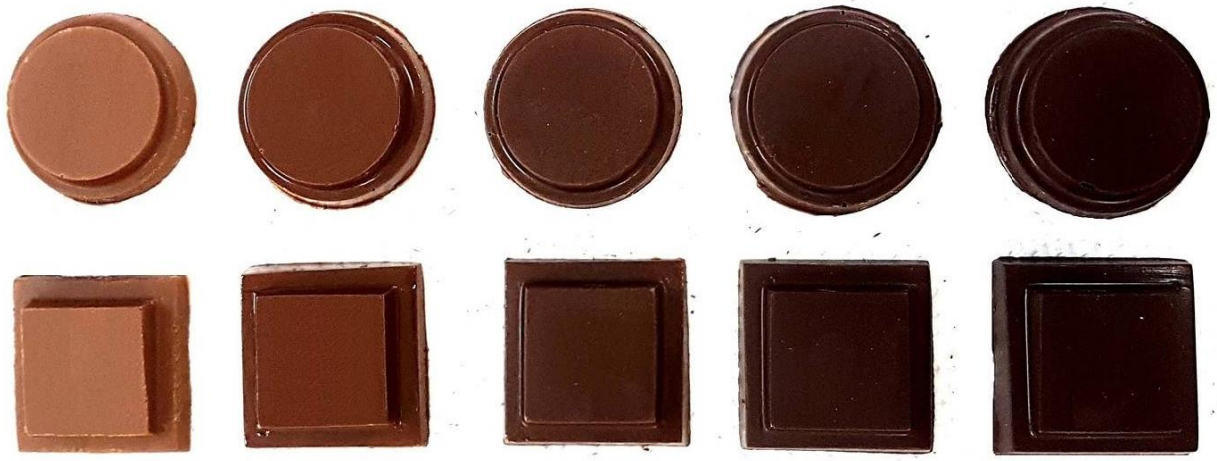

Figure 1 – From up to bottom, chocolate samples with 30%, 40%, 50%, 60%, and 70% cocoa content in both square (right) and round (left) shapes.

2.2.2 Participants

Two groups of 115 chocolate consumers each (N = 230) were recruited among UNICAMP's community through posters on campus and on social media groups. Each group was received at the Sensory Science and Consumer Studies Laboratory (LCSEC) of the School of Food Engineering (FEA) at UNICAMP on different consecutive days and performed the test in air-conditioned (21°C) individual booths. In a between-subjects design, the first group (73 females, mean age 23.85 years) received all five formulations of chocolate in rounded shape and the second group (61 females, mean age 24.28 years) received all in squared shape. The research was approved by the UNICAMP's Research Ethics Committee (protocol 20489019.4.0000.5404) and all participants read, signed, and were given a copy of an informed consent before the experiment. They were informed of all ingredients used on the samples and advised against allergies, intolerances, and diet restrictions. Lactose intolerant and vegans were advised not to participate.

2.2.3 Sensory evaluation

The intensity and hedonic rating tests were performed on FIZZ Network Sensory 2.47b (Couternon, France), samples were coded with 3-digit numbers and

presented monadically in disposable paper napkins on a balanced block design. Without receiving any information about the sample, subjects were instructed to just look at it and rate their expected sweetness, bitterness and creaminess in nine-points intensity scales ranging from 1 “not at all’ to 9 “extremely intense”, and how much they thought they would like it in a nine-points hedonic scale ranging from 1 “extremely dislike” to 9 “extremely like”. After submitting the ratings for a sample, participants could not see or change their answers. They were then asked to taste the sample and rate their perception of the same attributes using the same scales. After submitting their ratings for a sample, they could see or access their answers again and the code for the next sample appeared on screen.

2.2.4 Statistical analysis

For both pre-tasting and post-tasting chocolate ratings, a mixed multivariate analysis of variance (mixed-MANOVA) was conducted on the dependent variables ‘sweetness’, ‘bitterness’, ‘creaminess’, and ‘liking’. The within-participant independent factor was ‘cocoa content’, and the between-participant independent factor was ‘shape’.

A repeated-measures multivariate analysis of variance (RM-MANOVA) was used to compare the pre-tasting chocolate ratings to the post-tasting ratings. In this analysis, ‘rating type’ (before or after tasting) and’ cocoa content’ were the within-participants factors, ‘shape’ was the between-participants factor, and ‘sweetness’, ‘bitterness’, ‘creaminess’, and ‘liking’ were the dependent variables. All post-hoc pairwise comparisons were Bonferroni corrected, and differences were considered significant at $p \leq 0.05$.

In order to further explore the relationship between dis/confirmation of expectation and hedonic judgement, a Pearson’s correlation analysis was carried out. First, a difference index was generated by subtracting the post-tasting from the pre-tasting rating values of ‘sweetness’, ‘bitterness’, and ‘creaminess’ for each participant (i.e., ‘expectation’ minus ‘actual perception’ ratings). Next, the correlations were calculated between the difference indices and the post-tasting liking scores.

All statistical analyses were performed using SPSS, version 22.0 (IBM, Armonk, NY, USA).

2.3 Results

2.3.1 Pre-tasting ratings (expectation)

MANOVA revealed a significant main effect of shape [$F(4,203) = 2.86$, $p < 0.05$, Wilks' lambda = 0.95, $\eta^2p = 0.05$] and cocoa content [$F(16,191) = 84.32$, $p < 0.0001$, Wilks' lambda = 0.12, $\eta^2p = 0.88$] on participants' chocolate ratings. No significant interaction between shape and cocoa content was observed ($p = 0.43$), showing that their effects are independent.

Follow-up univariate tests showed significant effect of shape only on creaminess [$F(1,206) = 6.32$, $p < 0.05$, $\eta^2p = 0.03$]. Post-hoc comparisons showed that the participants expected the round chocolate to be creamier than the square chocolate (means ± standard error: 5.4 ± 0.1 and 4.8 ± 0.1, round and square respectively). Although not significantly [$F(1,206) = 3.14$, $p = 0.078$, $\eta^2p = 0.02$], the round chocolate was almost significantly expected to taste less bitter than the square chocolate (round: 4.8 ± 0.1, square: 5.2 ± 0.1) (see **Figure 2a**).

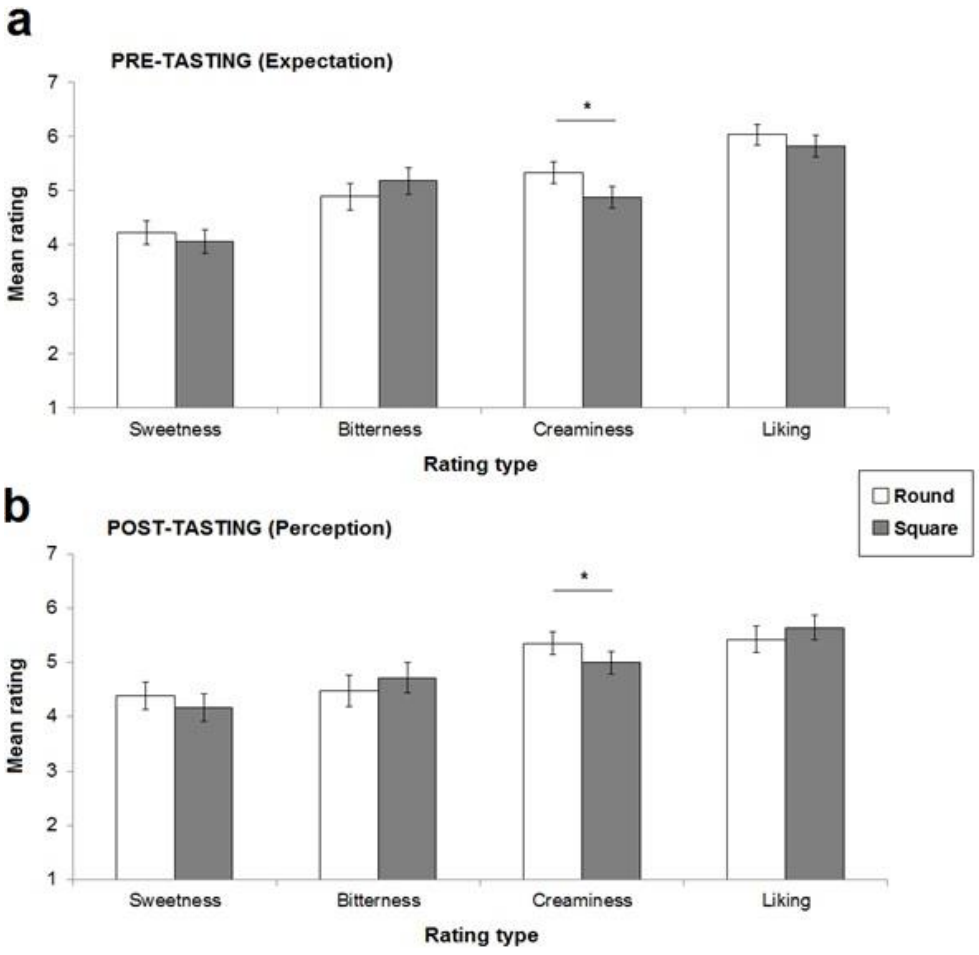

Figure 2 - Mean rating and standard error (SE) of (a) pre-tasting (expectation) and (b) post-tasting (perception) for the round and square chocolate shapes. * $p < 0.05$

As for cocoa content, univariate tests revealed significant effect on all four dependent variables, namely, sweetness [$F(4,204) = 253.51$, $p < 0.0001$, $\eta^2p = 0.55$], bitterness [$F(4,204) = 331.86$, $p < 0.0001$, $\eta^2p = 0.62$], creaminess [$F(4,204) = 107.73$, $p < 0.0001$, $\eta^2p = 0.34$], and liking [$F(4,204) = 15.36$, $p < 0.001$, $\eta^2p = 0.07$]. The addition of cocoa content as an independent factor on the manova is necessary to avoid misunderstanding its effects as errors or individual variance, but these results also confirm that the participants perceived the differences of colour among the formulations. Further pairwise comparison results are shown in **Table II**.

Table II: Mean rating and standard error (±SE) of the 30%, 40%, 50%, 60%, and 70% cocoa chocolates for sweetness, bitterness, creaming, and liking. Means in a column with the same superscript letter are not significantly ($p < 0.05$) different. * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

	Sweetness			**Bitterness**		
	Pre-tasting	Post-tasting	*Pre x Post*	Pre-tasting	Post-tasting	*Pre x Post*
30%	6.8 ± 0.1^{a}	7.2 ± 0.1^{a}	**	1.6 ± 0.1^{d}	1.0 ± 0.1^{d}	***
40%	4.7 ± 0.1^{b}	6.0 ± 0.1^{b}	***	4.5 ± 0.1^{c}	3.0 ± 0.1^{c}	***
50%	3.2 ± 0.1^{c}	3.7 ± 0.1^{c}	***	6.2 ± 0.1^{b}	5.5 ± 0.1^{b}	***
60%	3.1 ± 0.1^{c}	3.4 ± 0.1^{c}		6.1 ± 0.1^{b}	5.8 ± 0.1^{b}	*
70%	2.8 ± 0.1^{d}	1.2 ± 0.1^{d}	***	6.8 ± 0.1^{a}	7.9 ± 0.1^{a}	***

	Creaminess			**Liking**		
	Pre-tasting	Post-tasting	*Pre x Post*	Pre-tasting	Post-tasting	*Pre x Post*
30%	6.9 ± 0.1^{a}	6.4 ± 0.1^{a}	***	6.5 ± 0.1^{a}	5.5 ± 0.2^{c}	***
40%	5.2 ± 0.1^{b}	5.5 ± 0.1^{b}		6.1 ± 0.1^{b}	5.8 ± 0.2^{b}	
50%	4.5 ± 0.1^{c}	4.9 ± 0.1^{c}	*	5.7 ± 0.1^{c}	6.4 ± 0.1^{a}	***
60%	4.7 ± 0.1^{c}	4.8 ± 0.1^{c}		5.7 ± 0.1^{c}	6.3 ± 0.1^{a}	***
70%	4.2 ± 0.1^{d}	4.3 ± 0.1^{d}		5.4 ± 0.1^{d}	4.1 ± 0.1^{d}	***

2.3.2 Post-tasting ratings (actual perception)

MANOVA revealed a significant main effect of cocoa content [$F(16,197) = 2.34$, $p < 0.0001$, Wilks' lambda = 0.06, $\eta^2p = 0.94$] and a close to significant main effect of shape [$F(4,210) = 2.34$, $p = 0.056$, Wilks' lambda = 0.96, $\eta^2p = 0.04$]. Once again, no significant interaction between shape and cocoa content was observed ($p = 0.46$), showing that their effects are independent.

Follow-up univariate tests revealed significant effect of shape only on creaminess [$F(1,213) = 5.50$, $p < 0.05$, $\eta^2p = 0.03$]. Post-hoc comparisons showed

that the participants rated the round chocolate as creamier than the square chocolate (round: 5.4 ± 0.1, square: 4.9 ± 0.1) (see **Figure 2b**).

Univariate tests also showed significant effect of cocoa content on all four dependent variables, namely, sweetness [$F(4,204) = 444.30$, $p < 0.0001$, $\eta^2p = 0.68$], bitterness [$F(4,204) = 449.06$, $p < 0.0001$, $\eta^2p = 0.68$], creaminess [$F(4,204) = 43.40$, $p < 0.0001$, $\eta^2p = 0.17$], and liking [$F(4,204) = 36.68$, $p < 0.001$, $\eta^2p = 0.15$]. The addition of cocoa content as an independent factor on the manova is necessary to avoid misunderstanding its effects as errors or individual variance, but these results also confirm that the participants tasted the differences among the formulations. Further pairwise comparison results are shown in **Table II**.

2.3.3 Pre-tasting (expected) versus post-tasting (actual perception) ratings

RM-MANOVA revealed significant main effect of condition (rating type: expected *vs*. actual perception) [$F(4,191) = 12.38$, $p < 0.0001$, Wilks' lambda = 0.79, η2p = 0.21], but did not reveal a significant interaction effect between condition and shape on participants' ratings ($p = 0.10$). Univariate tests revealed significant effects of rating type on measures of sweetness [$F(1,195) = 3.94$, $p < 0.05$, $\eta^2p = 0.02$), bitterness [$F(1,195) = 25.19$, $p < 0.0001$, $\eta^2p = 0.11$] and liking [$F(1,195) = 12.58$, $p < 0.0001$, $\eta^2p = 0.06$), but not for creaminess ($p = 0.40$). Further post hoc tests showed that, overall, the chocolates were perceived as sweeter, less bitter, and less liked than expected (Sweet: pre: 4.1± 0.1, post: 4.3 ± 0.1; Bitter: pre: 5.0 ± 0.1, post: 4.6 ± 0.1; Liking: pre: 5.9 ± 0.1, post: 5.5 ± 0.1).

The RM-MANOVA test also showed a significant interaction effect between condition and cocoa content [$F(16,179) = 30.42$, $p < 0.0001$, Wilks' lambda = 0.27, $\eta^2p = 0.73$]. Follow-up univariate tests revealed significant interaction effects on ratings of all assessed variables, namely, sweetness [$F(4,192) = 61.57$, $p < 0.0001$, $\eta^2p = 0.24$), bitterness [$F(4,192) = 37.90$, $p < 0.0001$, $\eta^2p = 0.16$], creaminess [$F(4,192) = 4.46$, $p < 0.05$, $\eta^2p = 0.02$], and liking [$F(4,192) = 31.07$, $p < 0.0001$, $\eta^2p = 0.14$). The results of further post hoc tests are shown in **Table II**.

A Pearson's correlation analysis was performed to assess the relationship between the generated difference indices (see Section 2.4) and liking ratings. There were negative significant correlations between the creaminess difference indices and liking ratings in the samples 30% cocoa ($r = -0.27$, $n = 230$, $p < 0.0001$), 50% cocoa

(r = -0.16, n=230, $p < 0.05$), and 60% cocoa (r = -0.23, n = 230, $p < 0.001$) (see **Figure 3**). No significant correlations were observed between the sweetness and bitterness difference indices, and liking ratings in any cocoa content value.

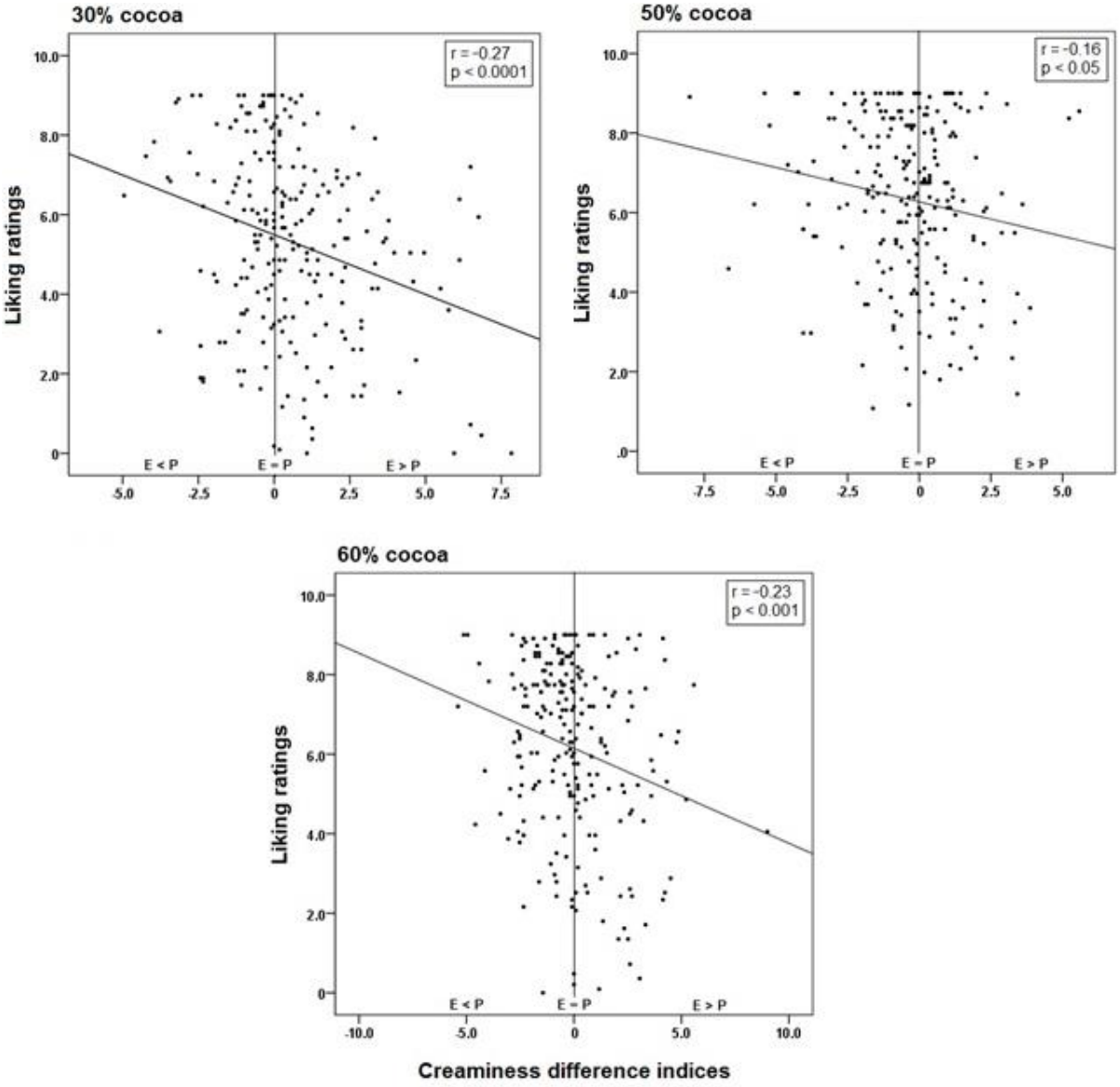

Figure 3: Scatter-plots showing the correlation between creaminess difference indices and liking ratings in cocoa content of 30, 50, and 60. The difference indices were created by subtracting the post-tasting from the pre-tasting rating scores of creaminess for each cocoa content. E = Expectation (i.e., pre-tasting scores); P = Perception (i.e., post-tasting scores).

2.4 Discussion

The hypotheses that shape would influence the expectation and perception of sweetness (**H1a** and **H2a**), bitterness (**H1b** and **H2b**), and liking (**H1d** and **H2d**) of chocolate were not confirmed. The effects on expected sweetness and

bitterness of dark chocolate reported by Wang *et al*. (2017) were not found, although being close to significance on bitterness (p = 0.078). On one hand, pre-tasting effects of product or contextual shape on tastes and liking were usually reported in published studies (Velasco *et al*., 2014; van Doorn *et al*., 2015; Velasco *et al*, 2015b; Machiels, 2018; Spence *et al*., 2019; Sousa *et al*., 2020a; Sousa *et al*., 2020b; Motoki and Velasco, 2021). The lack of published null effect, though, is expected due to publication bias (Fanelli, 2012). On the other hand, multiple articles reported positive (Liang *et al*., 2013; Faihurst *et al*., 2015; van Doorn *et al*., 2015; van Rompay *et al*., 2017; Chen *et al*., 2018; Sousa *et al*., 2020b) and null results (Piqueras-Fizsman *et al*., 2012; Machiels, 2018; Sousa *et al*., 2020a) of cross-modal effects of shape on post-tasting ratings of tastes and liking.

Several reasons could explain the lack of significant effects on taste expectation in this study. First, a cultural particularity of Brazilian consumers, although research recently showed cross-modal effects of shape-taste among Brazilian participants (Carvalho and Spence, 2018; Sousa *et al*., 2020a; Sousa *et al*., 2020b) and the close to significant difference on bitterness indicating that there is probably an association between angular chocolate and bitterness among Brazilians. Second, the symmetry of samples, as the asymmetry might have been a confounding in Wang *et al*. (2018) results. Third, because the shapes in this experiment were not angular or round enough in number and/or quality (Salgado-Montejo *et al*., 2015); the squared sample could have been more angular if it had had more and sharper angles (e.g. the shape of a star) and the rounded sample could have been more rounded if it had been a semi-sphere or a sphere, instead of a ‘2D’ circle with flat bottoms and tops. The choice for the ‘2D’ symmetric shapes, however, reflected the standard bar shape of commercial chocolates. Fourth, the choice for a between-groups design may also have resulted in weaker or not present cross-modal effects because they might have a relative instead of an absolute nature, being dependent on an explicit contrast of more than one shape (Spence, 2011; Charness *et al*., 2012). It is noteworthy, however, that repetitive exposure in a within-participants design may diminish the effects of shape (Motoki and Velasco, 2021)

The hypothesis that chocolates would be significantly expected as creamier (**H1c**) in rounded shape was confirmed. The effect on expectation was already reported by Wang *et al*. (2017) in a similar experiment with chocolates higher

in cocoa content (71% and 80%), a different experimental design (within-subjects with simultaneous presentation), different shapes (a “cube” and a semi-sphere), and in another country (Belgium). The replication of this effect in different conditions reinforces Ngo and Spence’s (2011b) hypothesis that mouthfeel may be more important for the cross-modal correlation between shapes, non-words, and chocolate. Interpreting Wang *et al*.’s (2017) results under this hypothesis, it might explain why expectation of creaminess was more influenced by shape than by tastes (they were all significantly affected but the F-values for creaminess, sweetness, and bitterness were 50.56, 33.62, and 23.41, respectively), an indicates that the stronger effect on creaminess than taste is not a particularity of Brazilians consumers. It also reinforces the suggestion by Wang *et al.* (2019) that the rounded chocolate could have been expected to be significantly sweeter than the angular one due to a carryover effect from creaminess. The present study did not replicate this effect.

The hypothesis that chocolates would be perceived as significantly creamier (**H2c**) in rounded shape was confirmed, which is an unprecedented finding as previous research with consumers only found null results (Wang *et al.*, 2017; Carvalho *et al*., 2017). These findings may be a particular association between the shapes and the creaminess of the chocolate specifically made for this research or a particular trait of Brazilian consumers. Against this last one, a previous study (Baptista *et al*., 2021) on chocolate visual/texture cross-modality reported null cross-cultural differences between Brazilians and French, at least for colour effect on melting expectation. The effect of shape on mouthfeel was previously shown by Lenfant *et al.* (2013) in descriptive tests with a trained panel and samples that were biometrically designed to influence melting by different surface areas, so their results are unlikely due to cross-modal effects. In addition to both samples in this experiment having the same dimensions (weight, height, and area), the results of Lenfant *et al*. (2013) strengthen the claim that the difference in creaminess found by the present study does not come from physical characteristics. Their trained panel did not report significant difference in any of the somatic sensations assessed (sticky, deformation, melting, irritating, smooth, and powdery) in chocolates with shapes similar to those in this study (“rectangle” and “round” in their experiment).

The hypothesis that shape effect would be weaker on chocolates on extremities of bitterness/sweetness intensity and stronger on middle range

chocolates (**H3**) was not confirmed. Manova showed significant effects of shape and cocoa content but no interaction between them, indicating that taste-balanced chocolates are not more likely to induce cross-modal or assimilation effects than taste-unbalanced chocolates.

The hypothesis that disconfirmation of expectations would lead to lower acceptability (**H4**) was confirmed for creaminess, despite it being the only descriptor that lacked a general significant difference between pre- and post-tasting ratings. As in the study by Carvalho *et al*. (2017), formulation and its average ratings of perceived sweetness, bitterness, and creaminess were stronger predictor of liking, but the mismatch between expectation and actual perception of creaminess was significantly correlated to liking for the 30%, 50%, and 60% cocoa chocolates. These results may be understood through the contrast theory, which states that people tend to dislike food when it does not meet their expectations (Cardello and Sawyer, 1992; Schifferstein, 2001), and that congruent multisensory cues are likely to be processed more easily, leading to higher liking ratings (Reber and Schwarz, 2001). This finding is not coherent with the results for the angular chocolate by Wang *et al*. (2017), as their sample was perceived significantly creamier and less liked than expected, while not being significantly different in sweetness or bitterness. However, Wang et al. (2017) also reported a possible contrast effect on their round chocolate, as it was less (but not significantly) liked than the angular one and their pre-tasting ratings were strongly different ($p < .01$) from post-tasting ratings in all descriptors, while the angular one was only different ($p < .05$) for creaminess and liking.

2.5 Conclusion

This study reports that consumers may expect and perceive a rounded shaped chocolate as creamier than in a squared shape, and that if the expectation of creaminess is not confirmed by sensory perception, acceptability may be negatively affected. The effect of shape on pre- and post-tasting ratings of mouthfeel together with the correlation between disconfirmation of creaminess and lower acceptability highlight the relevance of the shape of chocolate on consumers' experience. The significant result for creaminess adds evidence to the effect of shape on a mouthfeel attribute, a phenomenon less studied than on tastes, despite already evidenced by reactions to the change of Cadbury's milk chocolate bar (Spence, 2013). This study

evaluated the effect of two specific shapes of one food product on a particular group of people in a controlled environment, so future experiments should expand these questions to other food products, other cultural and environmental contexts, and other perceptions and attitudes of consumers. Nonetheless, the findings of the study already offers useful insights for chocolate manufacturers, chocolatiers, and sensory scientists interested in cross-modal effects of shape.

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CAPÍTULO 3 – EFFECTS OF PACKAGING COLOR

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Effects of packaging color on expected flavor, texture and liking of chocolate in Brazil and France

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Highlights

- Black packaging made consumers expect chocolates to be more bitter.
- Pink and yellow packaging made consumers expect chocolates to be sweeter.
- The effect of a packaging color on expected liking depended on chocolate type.
- Warm and cold classification of colors did not explain the effects of packaging color.
- The effects of packaging color were not significantly different between cultures.

Abstract

Recent research has shown that the colors of plateware, glassware, cups, packaging, and even the room and its lighting are able to influence consumers' preferences, expectations and perceptions of taste, flavor and texture of food and beverages. This study contributes to the subject by investigating how packaging colors affected the expectations of sweetness, bitterness, fruitiness, melting, and liking for chocolates in Brazil and France. Two groups of 210 consumers (N = 420) from each country evaluated samples of milk and dark chocolate packaged in seven colors: black, blue, brown, green, red, pink and yellow. Analyses of variance

(ANOVA) indicated that there were multiple significant effects of packaging color on consumers' expectations. Multiple factor analysis (MFA) showed that expected sweetness, fruitiness and liking were correlated to each other and inversely correlated to expected bitterness. While milk and dark chocolate were expected the least sweet and the most bitter when in black packaging, they were expected the sweetest and the least bitter when in yellow or pink packaging. Interestingly, the same black packaging made the milk chocolate the best rated and the dark chocolate the worst rated on expected liking, showing that a color may have inverse effects on expected liking depending on the type of chocolate. Although French consumers eat more chocolate and with higher cocoa content than Brazilians, the effects of packaging color were not significantly different between cultures.

Keywords
Consumer perception; Cross-cultural; Visual cues; Packaging; Color; Chocolate.

3.1 Introduction

Research has shown that not only the color of the product itself, but also the colors of the tableware, packaging, and environment can influence expectations and perception of a food or a drink (Spence, 2018). According to the predictive coding theory, this happens because when consumers see a product, such as a bar of chocolate, their brains immediately search for cues that match previous experiences and try to anticipate what it is and what are its characteristics (Piqueras-Fizsman & Spence, 2015). This process creates expectations that have been shown to affect behavioral response, sensory perception, and neural activation (Litt & Shiv, 2012; Okamoto & Dan, 2013), making the subject fundamental for food industries and food services interested in building a complete experience for their consumers.

It is argued that color is the most distinctive visual cue in a packaging (Singh, 2006), but its effects depend on many factors such as the level of attention (Brignell et al., 2009), the frequency of consumption of the product (Lick et al., 2017), the cultural context (Piqueras-Fiszman et al., 2012), the consumers' sensitivity to design (Becker et al., 2011), and the product itself (Zellner et al, 2018). A recent review (Spence and Velasco, 2019) summarized the multiple roles of packaging color on consumers' expectation and perception of identity, taste, flavor, fragrance,

healthiness, and willingness to pay. After the review, new contributions on the effects of packaging color reported that it may influence the emotions evoked by a burger (Merlo et al., 2018), its inside color (i.e., the side in contact with the product) may influence the desirability of yogurt (van Esch et al., 2019), and the color of the label may influence the expected taste of specialty coffee (de Sousa et al., 2020).

Specifically on the subject of this study, several significant effects of packaging color were reported on expected flavor, somatosensory sensations, and liking of food. Studies commonly associated these effects with the warm and cold classifications of colors. The first group includes colors of long length waves, like red, pink, and yellow; the second includes colors of short length waves, like blue, purple and green (Huang & Lu, 2015). First, Deliza and MacFie (2001) showed that an orange box made consumers expect passion fruit juice to be sweeter and less sharp, refreshing, and liked than a white box. Then, it was found that a dairy dessert in a yellow packaging was expected to be sweeter, creamier, and more liked than the same dessert in a black packaging (Ares & Deliza, 2010). Rebollar et al. (2012) reported that chewing gums in warm-colored packaging were expected to be sweeter, fruitier, and sourer than in cold colors or scale of grey; and Huang and Lu (2015) reported that cereal, ice cream, iced tea, and yogurt in red packaging were expected to be sweeter than in green or blue. Tijssen et al. (2017) found that a dairy drink in a red box was expected sweeter, creamier, more flavorful and liked than in a purple or a blue box; and that a sausage in a red box was expected to be saltier than in a green or blue box. Comparing juice, sorbet, and gums in red and yellow packaging, Matthews et al. (2019) showed significant effects on sourness and sweetness expectations. Finally, Rosa et al. (2019) reported that red-to-yellow, blue-to-green, and greyscale packaging influenced consumers' expectations for cookies tastes and liking in multiple directions.

Thus, besides protecting physically, chemically, and microbiologically a food product, packaging is a communication tool that draws attention, expresses identity, induces appetite, intensifies emotions, and conveys messages about the products' attributes (Velasco & Spence, 2019). Its potential to communicate might be particularly relevant for the 7.3 million tons of chocolate consumed globally (Conway, 2018), since they are usually eaten straight from the packaging and since there is a wide range of attributes that could be interesting to communicate: aromas (floral,

fruity, nutty), tastes (bitterness, sweetness, sourness), oral sensations (snap, melting, silky), types (white, milk, dark), categories (confectionary, compound, bean-to-bar), varietals (forastero, criollo, trinitario), and countries of origin (Colombia, Madagascar, Ivory Coast) (Beckett, 1994).

There are very few studies on the effects of packaging color on the expectations of chocolate taste, flavor, texture, and liking. A master thesis (van Lith, 2015) showed that a chocolate in red packaging was expected to be significantly healthier than in yellow packaging and a chocolate in dark brown was expected to be significantly more natural than in yellow or pink, but significant effects were not found regarding attractiveness or tastiness. Another research (Kovač et al., 2019) reported that strawberry-flavored chocolate was significantly more attractive when presented in vivid pink packaging than in a less saturated color. As these two studies did not tackle the effect of packaging color on tastes and texture of chocolate, further research could help pastry chefs, chocolatiers, designers, artisans, and industries to choose colors to their products' background, either it is a plate, a packaging or a shop window.

The purpose of this study was to evaluate the effects of seven different colors of packaging on expected sweetness, bitterness, fruitiness, melting, and liking of milk and dark chocolates. As color and taste associations were shown to vary among cultures (Wan et al., 2014), the questionnaire was simultaneously answered by a group of Brazilian and a group of French consumers. There are also expressive differences in the chocolate consumption between the two countries, although chocolate is commonly considered the most desired food in all the Western world (Richard et al., 2017). While the French eat 7.3 kg of chocolate per capita/year, with dark chocolate representing 30% of consumption among adults (Cohen, 2018), Brazilians eat 2.8 kg and only 3% of it is dark chocolate (Sebrae, 2018).

Based on the framework described above, the hypotheses were:

H1: the packaging color affects the expectations of sweetness, bitterness, fruitiness, melting, and liking of chocolate;

H2: Cold-colored packaging increase the expected bitterness (H2a), warm-colored packaging increase expected sweetness (H2b) and fruitiness (H2c);

H3: packaging colors differently affect expectations for milk and dark chocolates;

H4: packaging colors differently affect expectations of Brazilian and French consumers.

3.2 Methods

3.2.1 Stimuli

The stimuli (**Figure 1**) were pictures (958 x 958 pixels) of Lindt (Lindt & Sprüngli AG, Kilchberg, Switzerland) milk chocolate (min. 30% cocoa) and dark chocolate (min. 70% cocoa) in black, blue, brown, green, red, pink and yellow packaging. The packaging were folded rectangular (10.5 x 4 cm) pieces of Maldor's 130 g/m² colored paper (Clairefontaine, Etival Clairefontaine, France). The images are photographs, all taken in less than 5 minutes with a Galaxy S7 (Samsung, Manaus, Brazil) in an open space with direct sunlight. They were cropped, resized and had their contrast increased by 30% on Photoshop CS6 (Adobe, San José, CA, USA).

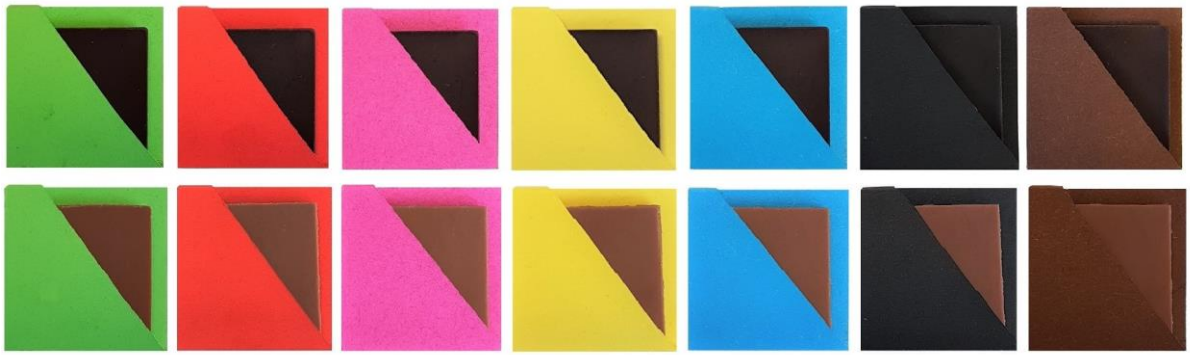


Figure 1. Dark chocolate (above) and milk chocolate (below) in green, red, pink, yellow, blue, black and brown packaging.

3.2.2 Participants

An email inviting chocolate consumers to participate in the research was sent to students and staff from AgroSup Dijon and the School of Biology, Earth and Environment Sciences of the University of Burgundy in France, and from the University of Campinas' School of Food Engineering and School of Agricultural Engineering in Brazil. They were informed that they were going to "answer a questionnaire about four chocolates" and nothing else on the subject or aim of the study. Together with the invitation, they received a link that directed to an online

survey designed and hosted on Compusense Cloud (Compusense, Guelph, Canada). Before starting the questionnaires, respondents read and were given the choice to accept or decline an informed consent form. This study was approved by the University of Campinas' Ethic in Research Committee (protocol 20489019.4.0000.5404).

Using their own devices (i.e., smartphones, tablets or computers), 445 chocolate consumers in France and 245 in Brazil completed the questionnaire during the first two weeks of March 2020. From them, 32 in France and 27 in Brazil were not included in the study for being underage, not being French or Brazilian, or giving an invalid answer to any of the questions. The first 210 valid respondents from Brazilian group were selected. This N was chosen so the maximum of data was used and the number of evaluations for each sample was balanced. Then, French participants were also selected in "first in, first included" criterium to match the Brazilian group in number (210), age range (18-60 y.o.), gender distribution (146 female), and mean age (26.40±8.32 y.o. in France, 26.40±6.69 y.o. in Brazil). This screening process was performed to obtain comparable groups across cultures (Ares, 2018).

3.2.3 Data collection

If respondents accepted to participate in the study, one of the samples from **Figure 1** was shown without any other information on the purpose of the study or on the sample brand, cocoa content, packaging color etc. Then, participants were asked to rate their expectation of sweetness, bitterness, fruitiness and melting using a 9-point intensity scale (1 = not at all, 9 = extremely) and expected liking using a 9-point hedonic scale (1 = extremely dislike, 9 = extremely like). The questions were "How sweet/bitter/melting/fruity do you think this chocolate is?" and "How much do you think you would like this chocolate?". All communication and questionnaires were in Portuguese in Brazil and in French in France, the translation to French was independently checked by three native speakers familiar with sensory analysis of food, but no equivalency test was performed.

Each participant monadically evaluated two samples of dark chocolate and two of milk chocolate, therefore, four of the 14 different samples. The balanced incomplete block was a Williams design provided by Compusense with 98 sets created by modifying a 14 x 14 Latin Square (Williams, 1949). The presentation of

the chocolate types and the order of appearance of the attributes were balanced between participants. After evaluating the samples, they were asked about what type of chocolate they usually eat (“white”, “milk”, “dark > 60% cacao”, and/or “dark < 60%”), with which frequency (“once a month”, “2 to 4 times per month”, “2 to 6 times per week”, or “everyday”), which are their nationality (open answer), gender (“masculine”, “feminine”, or “other”), and age (open answer).

3.2.4 Statistical analysis

Three-way mixed design analyses of variance (ANOVA) (model GLM, SAS Institute, Cary, USA) at 5% significance level were performed separately for each attribute, so Holm-Bonferroni was used to correct for multiple comparisons. ANOVA was performed on least square (LS) means to compensate for the incomplete block, with block as random factor because of the subjective nature of human behaviour, with country as between-subject fixed factor because each group has a different nationality and it was a controlled factor, and with sample as within-subject fixed factor because participants had different samples and it was also a controlled factor. When the sample effect was significant, Tukey-Kramer’s test was used for pairwise comparison, also corrected by Holm-Bonferroni. Further contrast analysis opposing dark and milk chocolate samples was performed using Excel 2010 (Microsoft, Remond, USA). Multiple factor analysis (MFA) was then performed on the samples by attributes by country matrix to provide a synthetic view of the data. MFA was followed by hierarchical cluster analysis (HCA) using the Ward’s agglomeration criterion on the first two dimensions of the MFA. Both MFA and HCA were performed using FactoMineR (Lê et al., 2008) for R (R Core Team, 2020).

3.3 Results

3.3.1 Participants

Type of chocolate consumed and frequency of consumption were both significantly different ($\chi^2 = 27.85$, df = 3, $p < .01$ and $\chi^2 = 10.48$, df = 3, $p = .02$, respectively) between the two groups. As shown in **Table 1**, more French participants reported eating dark chocolate (> 60% cocoa) and more Brazilians reported eating white, milk, and dark (< 60% cocoa) chocolates. Also, while French participants are well distributed between all frequencies of consumption (1/month to everyday), most

Brazilians eat chocolate on intermediary frequencies (2-4/month and 1-6/week). Furthermore, the French showed more specificity regarding the type of chocolate eaten (1.79 versus 2.05 types of chocolate per person, $\chi^2 = 9.67$, df = 3, p = .03).

Table 1. Chocolate consumption profiles of the Brazilian (N = 210) and French (N =210) groups, in percentage.

		Brazil %	France %
Type	White	31.90	20.00
	Milk	67.62	60.95
	Dark (<60%)	66.19	49.52
	Dark (>60%)	39.05	49.05
Frequency	1/month	8.10	15.24
	2-4/month	39.52	28.10
	2-6/week	44.76	33.81
	Everyday	7.62	22.86

3.3.2 ANOVA

The performed analyses of variance (**Table 2**) showed that significant main effects of country were found for all attributes but sweetness (means 5.08±1.94 vs. 4.98±1.85, in Brazilian and French groups, respectively). Brazilian participants expected the chocolates to be fruitier (5.20±1.85 vs. 4.73±1.94), more bitter (5.02±1.99 vs. 4.47±2.34), melting (4.07±0.51 vs. 3.65±0.28), and liked (6.45±0.42 vs. 6.04±0.43) than French. ANOVA also revealed significant main effects of sample for all descriptors, but no significant sample by country interaction was found.

Table 2. F values and p-values for each dependent variable from the three-way ANOVA with block, country and sample as factors. Significance of 5% after Holm-Bonferroni's correction for multiple comparison is p < .01.

	Sweetness		Bitterness		Fruitiness		Melting		Liking	
Effects	F	*p*	F	*p*	F	*p*	F	*p*	F	*p*
Block	1.7	< .01	1.44	< .01	2.6	< .01	1.99	< .01	1.77	< .01
Country	0.83	.36	22.43	< .01	10.33	< .01	17.98	< .01	12.06	< .01
Sample	197	< .01	196.42	< .01	4.19	< .01	108	< .01	6.62	< .01
Sample*Country	1.3	.20	1.81	.04	0.74	.73	1.49	.11	.78	.68

The mean ratings given by participants to the milk and dark chocolate samples in different packaging colors are shown in **Table 3**. Chocolate packaged in pink and yellow were generally expected to be sweeter, less bitter, more melting, and fruitier. On the other hand, black packaging increased bitterness ratings and lowered

sweetness, fruitness, and melting ratings. Scores for red, blue, and green samples were rarely significantly different from other samples. Brown packaging had the greatest number of significant differences, being rated as the sweetest, the least bitter, and most melting and liked among dark chocolates, as well as the most bitter and the least sweet among milk chocolates.

Black, blue, and green packaging had the lowest liking ratings among dark and the highest ratings among milk chocolates, while the opposite happened to pink and yellow, that is, they received the lowest ratings among milk and the highest among dark. Regarding fruitiness, the dark chocolate in pink and red packaging received the highest mean rates, they were significantly different from milk chocolate in blue and black packaging.

3.3.3 Contrast analysis

Further contrast analysis opposing dark and milk chocolate samples showed that type of chocolate had a greater significant influence on sweetness ($F(1,1342) = 2,395.42$, $p < .01$), bitterness ($F(1,1342) = 2,390.83$, $p < .01$), and melting ($F(1,1342) = 1,304.47$, $p < .01$); and a smaller significant effect on fruitiness ($F(1,1342) = 4.24$, $p < .05$) and liking ($F(1,1342) = 44.77$, $p < .01$). In addition to the contrast analysis, the greater standard deviations of the mean ratings (0.62 vs 0.38 in sweetness, 0.65 vs 0.48 in bitterness, 0.45 vs 0.30 in fruitiness, 0.52 vs 0.30 in melting, 0.39 vs 0.17 in liking) and the greater number of significant differences between samples (27 vs 9 in total) indicate that packaging color affected more the expectations for dark chocolate than for milk chocolate.

3.3.4 MFA and HCA

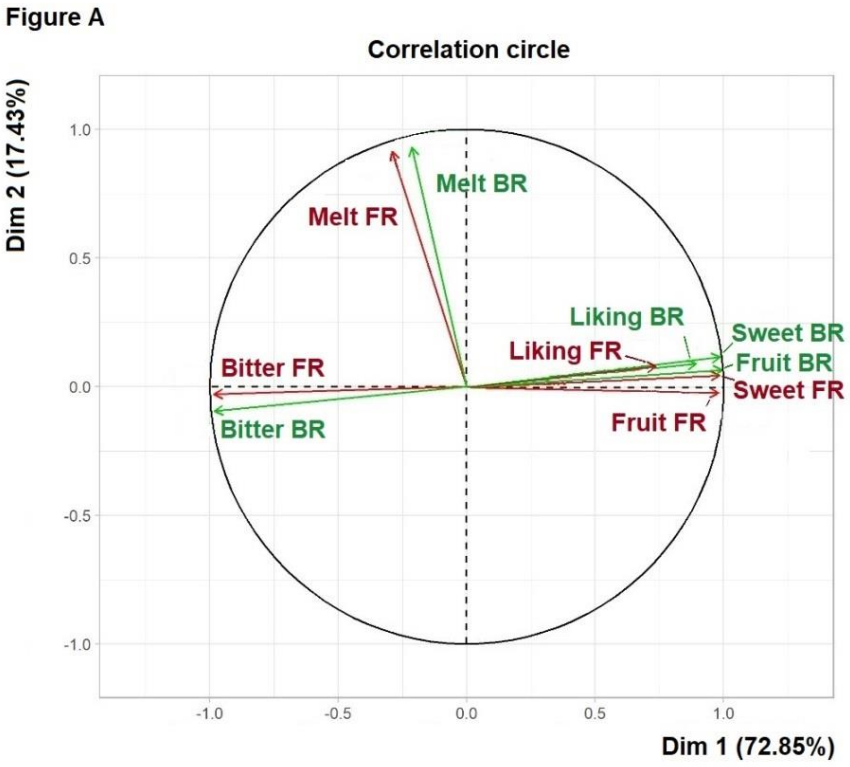
The correlation circle (**Figure 2A**) indicates small differences between the Brazilian and French groups. The first dimension explains 72.85% of the variance and is negatively correlated to bitterness (-.99 and -.99) and melting (.23 and -.32), while positively correlated to sweetness (.99 and .99), fruitiness (.99 and .99), and liking (.85 and .67) in Brazil and France, respectively. The second dimension is mostly correlated to melting (.93 and .90) and explains 17.43% of the variance so that the first two components of the MFA account for 90.28% of total variance.

Table 3. Least square means and standard deviation for sweetness, fruitiness, melting, and liking of dark and milk chocolates in seven packaging colors (1 = not at all, 9 = extremely). Values with the same letters in each column were not significantly different according to Tukey-Kramer's test at 5% significance corrected by Holm-Bonferroni for multiple comparison.

		Sweetness	Bitterness	Fruitiness	Melting	Liking
	Black	2.27±1.33^{e}	7.77±1.49^{a}	3.49±2.43^{bc}	2.92±1.70^{e}	5.45±2.28^{c}
	Blue	2.94±1.64^{de}	7.07±1.96^{abc}	3.59±2.13^{bc}	3.12±1.64^{de}	5.68±2.02^{bc}
	Brown	4.11±1.69^{c}	5.89±1.85^{d}	3.53±2.15^{bc}	4.48±1.87^{c}	6.54±1.74^{a}
Dark	Green	2.88±1.62^{de}	7.27±1.73^{ab}	4.05±2.22^{abc}	3.22±1.76^{de}	5.63±2.25^{bc}
	Pink	3.75±1.63^{c}	6.31±1.95^{cd}	4.62±2.21^{a}	3.79±1.15^{cd}	6.25±1.79^{abc}
	Red	3.33±1.68^{cd}	6.73±1.90^{bcd}	4.40±2.26^{ab}	3.48±1.77^{de}	6.08±1.78^{abc}
	Yellow	3.57±1.64^{cd}	6.31±1.90^{cd}	4.19±2.06^{abc}	3.70±1.89^{cde}	6.09±1.89^{abc}
	Black	6.62±1.49^{ab}	3.06±2.00^{efg}	3.41±1.92^{c}	6.32±1.54^{ab}	6.80±1.45^{a}
	Blue	7.20±1.44^{ab}	2.21±1.34^{fg}	3.44±1.99^{c}	6.50±1.74^{ab}	6.53±1.70^{a}
	Brown	6.43±1.53^{b}	3.25±1.88^{e}	3.50±1.97^{bc}	6.42±1.70^{ab}	6.62±1.53^{a}
Milk	Green	6.43±1.61^{b}	3.15±1.79^{e}	4.09±2.17^{abc}	5.86±1.93^{b}	6.30±1.71^{ab}
	Pink	7.14±1.24^{ab}	2.17±1.39^{g}	4.08±2.04^{abc}	6.71±1.73^{ab}	6.45±1.54^{ab}
	Red	6.60±1.58^{ab}	3.00±1.77^{ef}	3.98±2.20^{abc}	6.29±1.86^{ab}	6.60±1.55^{a}
	Yellow	7.31±1.32^{a}	2.30±1.36^{fg}	3.82±2.22^{abc}	6.74±1.49^{a}	6.35±1.70^{ab}

The individual factor map (**Figure 2B**) shows a clear separation between the milk (right) and the dark chocolates (left) on the first dimension. As shown by Table 3, milk chocolates were generally expected to be sweeter (means 6.82±0.38 vs. 3.26±0.62), less bitter (2.73±0.48 vs. 6.76±0.65) and fruity (3.76±0,30 vs. 3.98±0.45), more melting (6.41±0.30 vs. 3.53±0.52) and liked (6.52±0.17 vs. 5.96±0.39) than dark chocolate. The second dimension shows both chocolates packaged in pink, red, yellow, and green (up) in opposition to blue, black, and brown (down). Overall, the projections of each country for a same sample are more distant vertically than horizontally, indicating that melting is an important attribute to discriminate the answers from the Brazilian and French groups.

HCA revealed three clusters, the first with all milk chocolate samples (left), the second with dark chocolate samples in pink, red, yellow and green packaging (right/up), and third with dark chocolate packaged in brown, blue and black (right/down). The first cluster is correlated with sweeter, fruitier, and more liked samples; the two others are correlated with more bitter samples. The difference between the second and the third clusters is on the second dimension, the former being positively correlated to melting and the latter negatively.



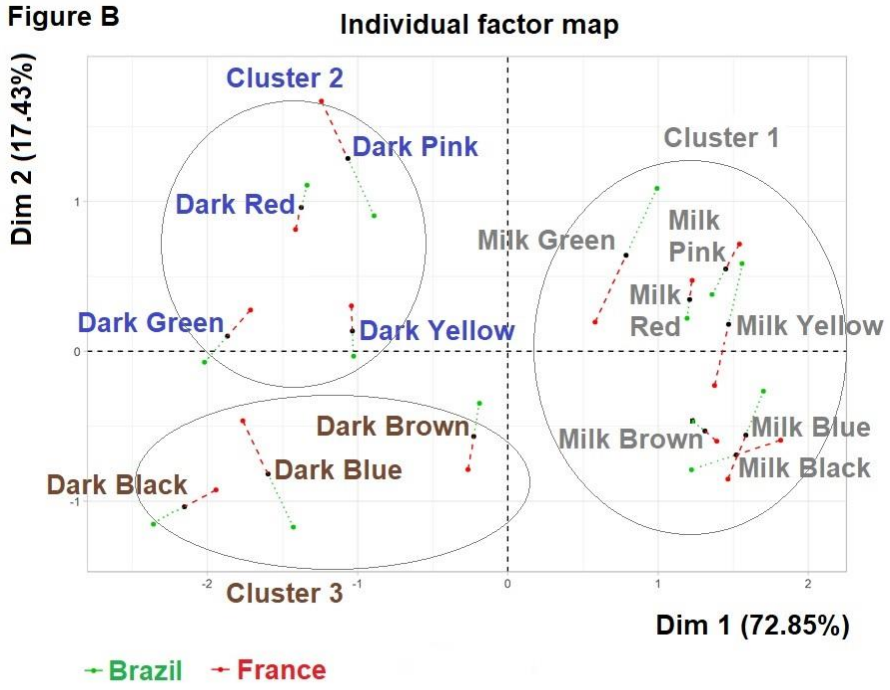


Figure 2. Multiple factor analysis: (A) Correlation circle of variables in Brazil and France; (B) Individual factor map with HCA clusters.

3.4 Discussion

3.4.1 Color

The first hypothesis (**H1**) was confirmed, that is, packaging colors significantly affected the expectations of sweetness, bitterness, fruitiness, melting and liking. A review of Spence and Velasco (2018) showed significant effects of packaging colors on other food and beverage products, but the only previous research on chocolate (van Lith, 2015) with 23 participants in Netherlands reported no significant effect of seven different colors of packaging on tastiness and attractiveness. Reasons why the present study found significant differences in liking, while the previous did not on tastiness and attractiveness, might be: the colors used, a cultural difference, the lack of other information (i.e., logo, label, illustrative picture) and/or just a greater number of participants.

As dark and milk chocolate were shown interleaved to make the aim of the study less obvious to participants, the sample effect accounted for the influence of chocolate type and of packaging color at the same time. All attributes were significantly affected by sample, but sweetness, bitterness and melting were more strongly than fruitiness and liking. On one hand, it is evident that type of chocolate was more relevant for sweetness, bitterness and melting, because all milk chocolate samples were significantly different from all dark chocolate samples in these attributes, regardless of packaging color. On the other hand, color was more relevant for fruitiness than type of chocolate, because none of the samples were rated significantly fruitier than the other type packed in the same color, while there were some significant effects between samples with different colors. On liking, effects of type and packaging color were dependent and can not be separated.

ANOVA revealed that black packaging is correlated to bitterness, while pink and yellow packaging are correlated to sweetness. Spence et al. (2015) indicated that the associations black-bitter and pink-sweet are commonly reported in different cultures, but not the yellow-sweet association, as this color is generally correlated to sourness. Yet, the yellow-sweet association is somehow coherent with the findings that Uruguayan consumers expected milk dessert in black packaging to be more bitter than in yellow or white (Ares & Deliza, 2010); that Spanish consumers expected chewing gum in grayscale (black to white) packaging to be less sweet than in warm (red to yellow) or cool (blue and green) colors (Rebollar et al., 2012); and

that Brazilians expected and perceived two coffees as sweeter when in a yellow cup (Carvalho & Spence, 2019).

Previous studies (Rebollar et al., 2012; Spence et al., 2015; Huang & Lu, 2015; Tijssen et al., 2017) reported that red packaging consistently increases expectations of sweetness, creaminess, and fruitiness in food products, but both chocolate samples in red packaging in this study received intermediary rates. Red was only significantly different from black on bitterness among dark chocolate and from pink on sweetness among milk chocolate. The faible effect might be due to the brightness and/or saturation used in this experiment, but van Lith (2015) also did not find significant effects for red packaging. Spence and Velasco's (2018) argued that it could be due to the Dutch association between red packaging and dark chocolate, the finding of the same result in France and Brazil indicates the lack of effect is more general in Western cultures.

Brightness and/or saturation could also be relevant to understand why samples in green packaging were rated significantly more bitter than in brown, pink, and yellow among dark chocolate, and blue and pink among milk chocolate. Two out of five studies reviewed by Spence et al. (2015) reported an association between green and bitterness, while four reported association with sourness. This ambivalence is not rarely explained by the prevalence of limes or lemons in the participants' culture (Carvalho & Spence, 2019), but in this study Brazilians distinctly associated green to bitterness. So, it is possible that the use of a brighter or darker shade of green might also play a role in the ambiguity, as a same culture might associate the first with the color of lime and the second with the color of dark green vegetables like broccoli and spinach.

The dark chocolate in brown packaging received the most ambivalent ratings, being the sweetest and the least bitter among dark chocolates, while it got the highest rating for bitterness and the lowest for sweetness among milk chocolate. This might be due to a dual effect of packaging color depending on chocolate type or, more likely, a miscalibration of the lighting by the camera used in this study, as the dark chocolate seems slightly brighter in the brown packaging than the other dark chocolate samples. This unbalanced lighting was unnoticed by the researchers before the conclusion of the data collection. Other samples might also have lighter

differences, but these differences varied according to the device used by the participant and are, at least in part, an effect of the contrast with the packaging color.

As the stimuli showed both chocolate and packaging, the samples were combinations of two colors. It has been shown that the combination of two congruent colors can be more strongly associated to a taste than the colors alone, especially when one is dominant and the other is auxiliary (Woods & Spence, 2016; Woods et al., 2016). In the present study, stronger effects of chocolate type indicate that the color of the chocolate was more important than the color of the packaging, suggesting that the former was perceived as foreground and the latter as background. That is understandable, since participants were asked to rate their expectations for the chocolate, not for the packaging. Thus, the results in this study are the effects of the combination of the packaging color with the color of chocolate and they might not be replicable in packaging that do not show the chocolate by transparency or illustration.

3.4.2 Warm and cold colors

The hypothesis that cold colors would increase bitterness ratings (**H2a**) and warm-colored packaging would increase sweetness (**H2b**) and fruitiness (**H2c**) ratings was not confirmed. First, MFA separated almost perfectly between cold and warm colors, except for both samples in green, that are together with pink, red and yellow on the upper part of the individual map (**Figure 2B**). Then, the milk chocolate in red packaging received much closer ratings to black, blue, green, and brown than to pink and yellow in sweetness and bitterness, being rated significantly more bitter than pink. In the other direction, the milk chocolate in blue packaging, a cold color, was rated the second most sweet and the second less bitter, being expected significantly less bitter than brown and green. Among dark chocolate the distinction was stronger, as all warm colors were rated-although not always significantly-as sweeter and less bitter than all cold colors, except brown, whose results are questionable.

Based on the cold and warm distinction, most studies compare and find significant effects on expectation and perception of food and drinks in red and blue packaging (Rebollar et al., 2012; Huang & Lu, 2015; Tijssen et al., 2017; van Esch et al., 2019; Rosa et al., 2019). This study found no significant difference between these

two packaging colors in any attribute of any chocolate type. These unusual results might be particular to chocolate packaging, to Brazilian and French cultures, or to the brightness and saturation used by this experiment, but they resemble the results on single colors reported by Woods & Spence (2016). Thus, researchers, industries, artisans, chefs, baristas, mixologists, packaging designers, food bloggers and photographers might consider contrasting black to pink or yellow, instead of red to blue when willing to influence the consumer's expectations.

3.4.3 Chocolate type

The third hypothesis (**H3**) was confirmed: packaging colors affected milk and dark chocolate differently. The greater standard deviation of the mean ratings and the greater number of significant differences indicate that packaging color affected more the expectations for dark chocolate than for milk chocolate. HCA also evidences that, as dark chocolate samples were separated in two clusters, while the milk chocolate samples were all grouped in one single cluster. This difference might be a consequence of a stronger and wider flavor and texture profile found in chocolates with higher cocoa content, and/or of the adding effect of shape and color congruency (de Sousa et al., 2020). As dark chocolate is related to squared-shapes and milk chocolate to round-shapes (Ngo et al., 2011), results could be different if the chocolate samples were rounded.

Regarding liking, packaging colors influenced the types of chocolate differently, even in opposite directions. **Table 2** shows that while the black packaging made the milk chocolate the most liked of all samples, the same packaging made the dark chocolate the least liked. The pink packaging had an opposite effect, making the dark chocolate the second most liked-only behind the one packed in brown, whose results are questionable as mentioned on the previous item-and the milk chocolate the second least liked among its type. Other colors, except brown, had similar ambivalent effects, increasing liking in one of the types and decreasing on the other.

If at first it would be intuitive and congruent to use dark packaging colors for dark chocolates and light colors for milk chocolates, this study shows that contrasting the chocolate type and the packaging color might make it more appealing for consumers. This might be an explanation for why some industries in Europe use red packaging for dark chocolate, as mentioned before. Perhaps the incongruity

between packaging color and chocolate type increases liking by making the product look more balanced, that is, “sweet colors” make dark chocolate look not too bitter, and “bitter colors” make milk chocolate look not too sweet.

This result does not necessarily mean that consumers individually prefer balanced chocolates, but that the group preference converges on balanced chocolates, something natural if we expect to have individuals with preferences normally distributed through all the spectrum of bitterness to sweetness. Therefore, food industries and services that use visual cues to sell their products to a broad public, such as chocolate bars in a supermarket or a chocolate-based pastry on a shop window, could improve their overall expected liking by using the right packaging or background color to the right type of chocolate. This resource should be used with care, though, since great disconfirmation of expectation may lead to a penalty on post-comsumption liking (Cardello & Sawyer, 1992).

3.4.4 Cross-cultural effects

The hypothesis that packaging color would affect Brazilian and French consumers differently (**H4**) was not confirmed. ANOVA combining the effects of country and sample showed no significant difference between groups, indicating that packaging colors affected ratings in the same general way in both groups. This understanding is also supported by the proximity between groups of the angles on the correlation circle (**Figure 2A**) and of the projections on the individual map (**Figure 2B**). For practical applications, it evidences that no change in packaging or context colors might be necessary for exporting chocolate products or offering a chocolate pastry dish in Brazil, France, and possibly many other Western cultures.

It is interesting to add that ANOVA found significant effects of country alone in all attributes except sweetness. These results show that the overall rating of bitterness, fruitiness, melting, and liking was different between groups, but not that packaging colors had different effects. For example, the Brazilian mean rating for bitterness of all samples was significantly higher than the French, probably a consequence of the smaller percentage of Brazilians that reported eating chocolate with more than 60% cocoa. As they are less familiar to bitter chocolates, they rated bitterness higher than the French.

In the other direction, it is unexpected that there was no significant difference for sweetness between countries with such different relationships with sugar, as Brazilian desserts are known for being distinctly sweet and sugar being part of the cultural, economic and political history of the country (Freyre, 2007). But the lack of difference does not necessarily indicate that they perceive sweetness equally, it only shows that both groups had similar expectations of sweetness when seeing images of chocolate samples. What Brazilian consumers would rate as a moderately sweet chocolate when tasted might still be too sweet for French consumers.

3.4.5 Limitations

As recent studies showed that the lightning and chroma may affect emotions more than the hue alone (Schloss et al., 2020) and, as color-taste effects might occur via emotions correspondences (Palmer et al., 2013), they were a relevant uncontrolled factor in this study. Further studies should investigate the effects of colors in more complex and realistic packaging, including more than one hue, brightness and/or saturation. As the aim of this study was to explore the color effect, no other detail was included in the packaging, such as brand, weight, claims, product description or illustration. Participants of both groups were recruited from institutions that teach and research Food, Biology and Agriculture, therefore their background knowledge of scientific methods and/or food likely influenced the results. This study also did not check participants for color blindness, nor controlled the final resolution and color balance of the pictures since participants used their own devices to answer the questionnaire. To make the goal of the experiment less obvious to participants, this study chose to collect and analyze data on milk and dark chocolate samples together. This might have led to a smaller number of significant differences, particularly among milk chocolate samples, because the effects of packaging color on dark chocolate were stronger. Another step forward on the subject would be testing if these effects on expectation affect consumers' actual perception, because that is not always the case (Zellner et al., 2018).

3.5 Conclusion

This study was the first to find significant effects of several packaging colors on expected taste, flavor, texture and liking of chocolate. It was also the first to evaluate that for two types of the same food product with opposing sensory qualities (bitter x sweet) among two different cultures. Another difference was showing both the product (chocolate) and the packaging on the picture. Significant interactions between chocolate type, packaging color and culture showed that effects are co-dependent, making it important to consider and control all these variables together. It is possible to conclude that black packaging induces greater expectation of bitterness and yellow and pink packaging induce greater expectation of sweetness and melting in chocolate. Also, that the effects of a packaging color on expected liking might take opposite directions for milk and dark chocolate. The effects of context color on food must be further investigated to understand how industries, artisans, chefs, baristas, mixologists, packaging designers, food bloggers and photographers may use it to influence the consumers' expectations for its products and services.

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CAPÍTULO 4 – COLOUR IS TO FLAVOUR AS SHAPE IS TO TEXTURE

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Colour is to flavour as shape is to texture: A choice-based conjoint study of visual cues on chocolate packaging

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Abstract

The effect(s) of visual cues and their crossmodal correspondences in the context of food and beverage packaging have increasingly been researched over the last two decades. The study reported here contributes to this subject by integrating four visual variables into a single test using a choice-based conjoint analysis approach. The contribution of colour (pink/black), typeface (rounded/angular), ingredient image (milk/chocolate), and shape (curved/flat) present on milk chocolate packaging are evaluated. Mock-ups covering all 16 possible combinations were evaluated online by a total of 480 Brazilian chocolate consumers for preference, expected sweetness, and expected creaminess. The participants also listed the first three words that came to mind for a subset of four of the samples. The data from the choice task was statistically analysed by mixed logit model and from the related words task by correspondence analysis. Significant effects of colour, typeface, and ingredient on participants' preference, of colour and shape on sweetness, and of shape on creaminess, were revealed. Except for ratings of expected creaminess, colour was the most relevant attribute on all independent variables. These results further our understanding concerning how multiple visual cues may combine to influence consumer preference and crossmodal correlations with taste and texture. Although this research was conducted on the packaging of bars of chocolate, the consistency of the findings with those studies that have used other products should

encourage designers and manufacturers to take these findings into account when creating packaging for food and beverage in general.

Keywords
Crossmodal; Consumers; Expectation; Preference; Design; Word Association.

4.1 Introduction

Until the second half of the 20th Century, food and beverage packaging was primarily regarded as little more than a tool for the transportation and preservation of the contents (see Hine, 1995; Velasco & Spence, 2019a, for historical reviews). It was the increasing popularity of supermarkets in the West that made marketers pay attention to its role in capturing the consumer's attention and influencing their preferences (Favre & November, 1979; Stern, 1981; Velasco & Spence, 2019b). More recently, designers and scientists have also grown increasingly interested in how packaging, more than standing-out and being visually attractive, contributes to the multisensory experience of consumption from visual inspection on the shelf through to eventual disposal (Schifferstein et al., 2013). Certain of its contributions come from visual aspects, such as colours, images, typefaces, and shapes, that have been shown to influence people's preferences, expectations and perceptions of healthiness, quality, value, liking, as well as tastes, aromas, and texture (see Velasco & Spence, 2019a; Wheatley, 1973, for reviews).

A few recent studies tested two or more visual variables combined, usually colour, shape, background patterns, and/or typeface, on a food or beverage packaging (for reviews: Matthews et al., 2019; Velasco & Spence, 2019a). Some of these studies included a word-related task (Ares & Deliza, 2010; Piqueras-Fiszman et al., 2013), others used eye-tracking (Piqueras-Fiszman et al., 2013) or even a choice-based task to evaluate the preference of children (Ares et al., 2016). To the best of our knowledge, no study has used choice-based tasks to evaluate taste intensity, preferring rating tasks for that purpose. Velasco et al. (2014) conducted a 'categorization task' in which their participants had to indicate whether a bottle was more appropriate for a sweet or a sour product, but they were interested in how long it took the participants to make the decision. Furthermore, no study appears to have

directly assessed texture, rather it has only been assessed indirectly on related word tasks, as participants voluntarily included texture terms (Ares & Deliza, 2020).

With regards to interactions between different visual treatments, such as colour and shape, Deliza and MacFie (2001) reported interactions between colour, picture, and shape. Piqueras-Fiszman et al. (2013), meanwhile, reported an interaction between the texture of a jam jar and the presence of a fruit picture. Velasco et al. (2014) found multiple interactions between shape, typeface, and name on participants' reaction times (RTs) and their ratings of the expected sweetness and sourness of the product. Many of the studies that have tested for two or more visual cues on packaging did not analyse for interactions (Ares & Deliza, 2010; Ares et al., 2016; Kovač et al., 2019; da Rosa et al., 2019; Sousa et al., 2020a; van Lith, 2015) or else reported null results (Becker et al., 2011; Heartherly et al., 2019; Matthews et al., 2019; Piqueras-Fiszman et al., 2012).The objective of the present study was to understand how much each visual cue in a packaging contributes to the consumers' preference, expected sweetness, and expected creaminess of a milk chocolate as well as if the various effects interact. Specifically, the hypotheses were:

H1: Pink packaging, rounded typeface, milk splash, and curved shape will increase expected preference, sweetness, and creaminess.

H2: Colour is the most important attribute on all dependable variables and the word association task.

H3: Congruent attributes (e.g., pink, rounded, milk, and curved vs. black, angular, chocolate, and flat) will mutually enhance each other's effects whereas incongruent attributes will possibly cancel each other out.

These hypotheses were chosen because chocolate is an appropriate product to evaluate crossmodal effects of packaging features, as it is so often consumed directly from the packaging, thus likely increasing the influence of visual aspects on consumer perception (Spence & Velasco, 2019). Studies already show that the colour of chocolate packaging can influence healthiness, naturalness, and perceived tastiness (van Lith, 2015), expected sweetness, bitterness, creaminess, and liking (Baptista et al., 2021), and expected and perceived bitterness and sweetness (Sugimori & Kawasaki, 2022). Furthermore, background patterns, illustration, and colour saturation have also been shown to influence consumer preference (Kovač et al., 2019). The shape of chocolate has already been shown to

affect people's expectations of sweetness, bitterness, and creaminess in chocolate (Baptista et al., 2022; Wang et al., 2017), and also perceived creaminess (Baptista et al., 2022; see also Spence, 2014). No previous study on the effects of a milk or liquid chocolate splash on chocolate packaging has been published, although the presence or nature of images on packaging have been shown to influence willling to buy and expected freshness, naturalness, novelty and tastes (Machiels & Karnal, 2016; Pantin-Sohier & Miltgen, 2012; Rebollar et al., 2017; Smith et al., 2015).

To test these hypotheses, this research chose to use a choice-based conjoint analysis complemented by a word association task. According to Almli and Naes (2018), the term conjoint analysis is a generic expression for those experimental studies that are designed to better understand the consumer's preferences among products that combine specific attributes manipulated in different levels. The choice-based method was chosen over the rating-based because the first allows the participants to evaluate pictorial stimuli in a quick, impulsive, and holistic manner, thus making it possible to combine a full-factorial sample design and a complete block set design (for more on their differences, see Almli & Naes, 2018; Ares et al., 2016). This method is appropriate for those products, such as chocolate, that are typically bought without much thought or rational comparison between different product offerings.

Traditionally, conjoint analysis has been used to assess preference or willingness to pay and so better mimic the situation found in the marketplace (Rao, 2014). The result is usually the measure of utility, or how much each attribute contributes to the consumers' overall acceptability or willingness to purchase (WTP) a product. In the present research, conjoint analysis was used to measure not only the preference but also the crossmodal influence of visual cues on taste and texture expectations. It has been suggested that crossmodal correspondences can be considered as arbitrary statistical correlations in the marketplace between stimuli from different senses, such as a specific colour (e.g., pink) and a particular taste (e.g., sweet), a shape and a sound (e.g., see Spence, 2011; Spence & Levitan, 2021).

While choice-based conjoint analysis has already been used to assess healthiness (Annunziata & Vecchio, 2013) and emotional responses (Jervis et al., 2014), it has not been used to evaluate crossmodal effects. Sensory attributes were

assessed in choice-based conjoint studies as treatments, for example, with samples varying in sweetness, seasoning or flavour intensity (de Andrade et al., 2016, Endrizzi et al., 2011; Enneking et al., 2007, Hoppert et al. 2012). It has also been used by Velasco et al. (2014), as already mentioned, to measure how long participants took to make a decision of the appropriateness of the taste. The use of a choice-based task to measure crossmodal effects was deemed valid as traditional methods such as paired comparison, triangle tests, or ranking also require the participants to assess sensory intensity through choice (Lawless & Heymann, 2010). Consequently, a fourth hypothesis was added to the study:

H4: Results from this choice-based test will be similar to those from rating evaluations from previous studies.

This research also used a qualitative method to enrich the results and further explore the quantitative data concerning preference, as did Ares and Deliza (2010) in a very similar study with the shape and colour of milk dessert packaging. Open text analysis has already been shown to deliver comparable results to internal preference mapping (ten Kleij & Musters, 2003), helping researchers to identify and understand the drivers for consumers' preferences in the context of complex products. In a word association task, participants write a few words that first come to mind when prompted with a verbal and/or visual stimulus (Mesías & Escribano, 2018). Just as the choice-based task, word association is supposed to be fast, instinctive, and spontaneous, thus providing 'relatively unrestricted access to mental representations of the stimulus' (Ares & Deliza, 2010, p. 930), again appropriate for chocolate purchase decisions.

4.2 Material and methods

4.2.1 Ethics

This study was approved by the University of Campinas' Ethic in Research Ethics Committee of the University of Campinas (protocol 20489019.4.0000.5404). All of the participants were asked to read and sign an informed consent form prior to taking part in the research.

4.2.2 Stimuli

Following Ares et al. (2011), a market research of commercial packaging features was created by surveying milk chocolate bars that were available in the four main supermarkets in Campinas, Brazil. To narrow the research in the biggest and most common market segment (Sebrae, 2018), only industrial chocolates made in Brazil and available in more than one supermarket chain were included. Six different brands were found and an analysis of their packaging revealed five visual design elements, as shown in **Table 1**. They were all horizontal, metallic packaging, full coloured, with brand on the left upper corner, 90 g weight, chocolate picture, milk/melted chocolate splash etc.

Table 1 - Market research of visual elements in industrial chocolates found in supermarkets from Barão Geraldo, Campinas, Brazil.

	Brand 1	**Brand 2**	**Brand 3**	**Brand 4**	**Brand 5**	**Brand 6**
Colour	Red	Blue	Yellow	Brown	Blue	Orange
Chocolate shape	Rounded	Rounded	Rounded	Angular	Rounded	Rounded
Typeface	Rounded	Angular	Rounded	Angular	Angular	Rounded
Splash	Milk	None	Chocolate	None	Chocolate	Chocolate
Patterns	None	Angular	None	None	None	None

Two levels for each of the four attributes were chosen: colour (pink/black), typeface (angular/round), ingredient (milk/melted chocolate), and chocolate shape (straight top/curved top). Because background patterns were present in only one of the packaging exemplars, and in order to limit the number of variables to four, this was not included as a variable in the study. An earlier study with chocolate packaging and Brazilian consumers (Baptista et al., 2021) had already revealed that pink packaging elicited the sweetest taste expectations, while black elicited the least sweet expectations. Another previous test (Baptista et al., 2022) found that Brazilian consumers expected and perceived rounded chocolates to be creamier than squared chocolates. Angular and rounded typefaces on packaging have also been shown to influence participants' coffee taste expectations in Brazil (see Sousa et al., 2020b). Finally, no study on the presence of ingredients images in chocolate packaging has

been published to date, so the two options found in the benchmark were used, milk or melted chocolate.

A design studio (Atucana, Porto Alegre, Brazil) created 16 mock-ups that covered all possible combinations of the four key attributes and their two levels each, as shown in **Table 2**. The pictorial stimuli emulated the typical industrial Brazilian chocolate bar and the attributes and levels were carefully designed to look natural to a Brazilian consumer and to be as equivalently visible as possible (Almli & Naes, 2018).

Table 2 - Full factorial design of the four treatments and the two levels associated with each.

Sample #	Colour	Typeface	Splash	Shape
1	Pink	Rounded	Milk	Flat
2	Pink	Rounded	Milk	Curved
3	Pink	Rounded	Chocolate	Flat
4	Pink	Rounded	Chocolate	Curved
5	Pink	Angular	Milk	Flat
6	Pink	Angular	Milk	Curved
7	Pink	Angular	Chocolate	Flat
8	Pink	Angular	Chocolate	Curved
9	Black	Rounded	Milk	Flat
10	Black	Rounded	Milk	Curved
11	Black	Rounded	Chocolate	Flat
12	Black	Rounded	Chocolate	Curved
13	Black	Angular	Milk	Flat
14	Black	Angular	Milk	Curved
15	Black	Angular	Chocolate	Flat
16	Black	Angular	Chocolate	Curved

4.2.3 Participants

The participants were recruited through posts on social media groups related to the University of Campinas (Unicamp) and emails to staff and students from Unicamp's School of Food Engineering. The respondents were also encouraged to share the research invitation with their friends and relatives. The invitation only explained that participants had to be chocolate consumers over 18 years old and that they were going to 'answer a questionnaire about chocolate'. During the last two weeks of October 2021, 507 chocolate consumers answered the online questionnaire using their own devices (i.e., smartphones, tablets, or computers), but to keep the sample design balanced only the first 480 respondents were considered.

4.2.4 Data collection

The questionnaire was designed and hosted on Compusense Cloud (Compusense, Guelph, Canada) and had four sections in the following order: preference, word association task, sweet/creaminess evaluation, and participant demographics. This order was chosen so preference was unbiased by rationalisations derived from asking for associated-words, sweetness, and creaminess. For the same reason, word association tasks were presented prior to the sweetness and creaminess evaluations. The pair-choice task was chosen over a rating task, both because it is faster and more instinctive, thus keeping the full-factorial design and the expected time of participation down to under five minutes.

In the first section, in a pair-choice task (Almli & Naes, 2018), the participants were shown four pairs of samples, one pair at a time, and asked to imagine that they would eat one of them and to answer the following question: 'Which of the two would you choose?'. Subsequently, the participants were monadically shown two packages of chocolate and asked to 'write the first three words that come to mind when you see this chocolate' (Rodrigues et al., 2020). Only four out of the 16 packages were evaluated in this task (see **Figure 1**). Samples 2, 7, 12, and 13 (see **Table 2)** were chosen so each level of each treatment appeared in half of them.

In the third step of the test, the participants were shown another set of four pairs of stimuli, one pair at a time. They were asked 'Which one do you think is the sweetest?' and 'Which one do you think is the creamiest?'. Choice was mandatory in both Sections 1 and 3, because we were not interested in market penetration, all

participants confirmed that they were chocolate consumers (Asioli et al., 2016), and they were asked for a hypothetical preference or an instinctive guess concerning the sensory profile of the chocolate.

The sample set was designed to show all 16 samples to all participants (complete block design), eight in the first section and the other eight in the third section. It was also designed to balance the pairing between samples, showing each of the 240 possible pairs twice. However, as 240 is not divisible by eight, the pairs could not be balanced in each of the eight positions. Following the informal statement ‘block what you can, randomise what you cannot’ (Medeiros et al., n.d.), the position was randomised and the order of the pairs were folded over for the second half (241-480) of the sets, generating a choice design without overlaps (Johnson et al., 2006) to reduce any order effects.

Figure 1: Packages presented in the word association task depicting all visual features used in the study: pink and black colours, rounded and angular typefaces, milk and chocolate splash, curved and flat chocolate shape.

In the fourth and final section of the questionnaire, personal information was collected. This included the participant’s chocolate consumption frequency (monthly, biweekly, weekly, or daily), the usual type of chocolate eaten (white, milk, semisweet, and/or dark), as well as their age, gender, and education level.

4.2.5 Statistical analysis

Statistical analysis was conducted on R 4.1.2 (R Core Team, 2021) and RStudio 2021.09.0 (RStudio Team, 2021), unless otherwise stated.

4.2.5.1 Choice-based analysis

Data from the choice-based task was analysed through Mixed Logit (ML) Model, a discrete choice model (DCM) that allows the inclusion of 'random parameters of any distribution and also correlations between random factors' which 'intrinsically models preference heterogeneity, i.e., interindividual preference variations' (Asioli et al., 2016, p. 177). The ML Model was run by the mlogit package (Croissant, 2020) with adapted scripts from Feit et al. (n.d.). The analysis checked for individual and interaction effects of colour, typeface, ingredient, and shape. It also checked for individual effects of age, gender, educational level, type of chocolate usually consumed, and frequency of chocolate consumption of the participants. The utility ML model chocolate j for individual i in choice occasion t is written:

$$U_{ijt} = \beta_{1i}Colour_{ijt} + \beta_{2i}Face_{ijt} + \beta_{3i}Ingredient_{ijt} + \beta_{4i}Shape_{ijt} + \beta_{5i}(Colour*Face)_{ijt} + \beta_{6i}(Colour*Ingredient)_{ijt} + \beta_{7i}(Colour*Shape)_{ijt} + \beta_{8i}(Face*Ingredient)_{ijt} + \beta_{9i}(Face*Shape)_{ijt} + \beta_{10i}(Ingredient*Shape)_{ijt} + \beta_{10i}Age_{ijt} + \beta_{11i}Gender_{ijt} + \beta_{12i}Educ_{ijt} + \beta_{13i}Type_{ijt} + \beta_{13i}Freq_{ijt} + \varepsilon_{mjt}$$

The relative importance of the attributes (Hair et al., 2019) was calculated using Google Sheets (Google, MountView).

4.2.5.2 Word association analysis

The data from the word association task were stemmed by the package tm (Feinerer et al., 2018). As in Symoneaux et al. (2012), there were many synonyms that expressed essentially the same, or similar, meanings, so three researchers independently grouped the stemmed words according to their semantic and contextual understanding of them. They then gathered to discuss their groups and converge to a consensus on the final groups (Rodrigues et al., 2020). The final list of grouped words was then ordered by frequency using the dplyr package (Wickham et al., 2021). Correspondence analysis (CA) was run on the contingency table (stimuli x categories) using the package FactorMineR (Lê et al., 2008). Only those groups

appearing more than 27 times (1% of total entries) across the stimuli were included in the analysis.

4.3 Results

4.3.1 Participants

The 480 participants were all between 18 and 69 years old (mean = 31.54 y.o., s.d. = 10.54 y.o.). As shown on **Table 3**, they were mostly highly educated, ate chocolate weekly or daily, and preferred milk or semisweet chocolate. Mixed logit revealed some significant correlations between age and preference (older participants preferred the chocolate splash, estimate = 0.50±0.19, $p < .01$), frequency of consumption and sweetness (participants that eat chocolate once a month evaluated chocolates packed in pink as sweeter, estimate = -0.37±0.13, $p < .01$), education level (postgraduates thought pink was sweeter, estimate = 0.88±0.28, $p < .01$). No difference between gender was found, nor for creaminess. **Figure 2** shows a CA factor map of demographic groups and preference for treatments. Group age between preferred the chocolate splash, participants that eat chocolate less regularly (monthly) preferred the black packaging, participants that usually eat white and milk chocolate preferred more the pink packaging.

Table 3 - Demographic and chocolate consumption profile of the 480 participants. Type of chocolate usually consumed sums to more than 100% because participants could check all that applied.

Gender			**Education level**		
	n	%		n	%
Female	350	72.92%	High School	22	4.58%
Male	129	26.88%	Graduate	205	42.71%
Non-binary	1	0.21%	Postgraduate	253	52.71%
Frequency of chocolate consumption			**Type of chocolate consumed (CATA)**		
Monthly	8	1.67%	White	117	24.38%
Biweekly	87	18.13%	Milk	244	50.83%
Weekly	257	53.54%	Semisweet	281	58.54%
Daily	128	26.67%	Dark	141	29.38%

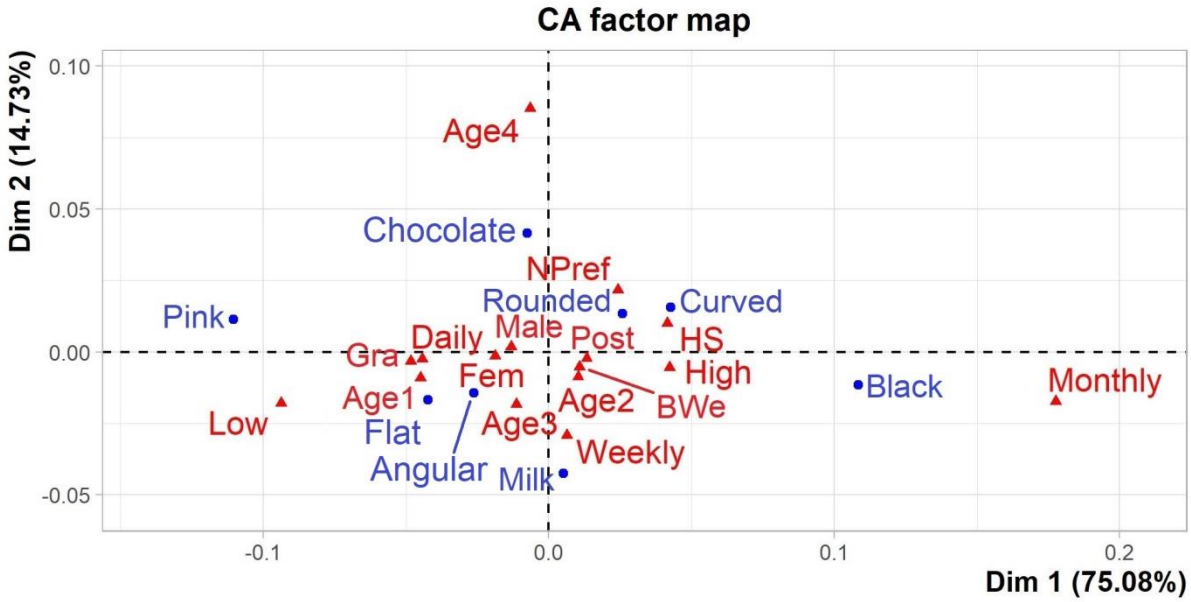

Figure 2: Correspondence analysis factor map of the number of times each treatment (colour: "Pink" "Black", typeface: "Rounded" or "Angular", ingredient: "Milk" or "Chocolate", and chocolate shape: "Curved" or "Flat") was chosen by each demographic group (frequency of chocolate consumption: "Monthly", "Bwe" = biweekly, "Weekly", or "Daily"; preferred percentage of cocoa: "Low", "Npref", or "High"; Education: "HS" = high school, "Grad" = graduate, or "Post" = postgraduate; Gender: "Fem" or "Male"; Age groups: "Age1" = 18-25 y.o., "Age2" = 26-35 y.o., "Age3" = 36-45 y.o., "Age4" = over 46 y.o.).

4.3.2 Choice-based results

The Mixed Logit Model indicated significant effects of colour, typeface, and ingredient on preference; colour and chocolate shape on sweetness; and chocolate shape on creaminess, as shown on **Table 4**. Participants preferred the chocolate in black packaging, rounded typeface, and with a chocolate splash. They also expected a sweeter and creamier chocolate when the shape of the chocolate was curved. They also expected a sweeter product when the packaging was coloured pink (see **Figure 3** for main effects). Only two significant interactions between attributes were found, colour:ingredient and colour:shape, both on sweetness. When the packaging was pink, participants chose the milk splash and the rounded shape more often. **Table 4** also shows the relative importance of attributes indicating that while chocolate shape was the main attribute for creaminess, colour was the most important attribute for sweetness and preference.

Table 4 - Estimated parameters, standard error, and p-value for ML model with main effects and interactions, and the relative importance of the four conjoint variables on expected creaminess, sweetness, and preference. p-values followed by * were significant at 5%, ** at 1%, and *** at 0.1%, respectively.

	Estimate	Std. Error	p-value	Relative importance
Main effects - Preference				
Pink colour	-1.41	0.20	1.79e-12 ***	53.44%
Rounded type	0.56	0.20	5.73e-03 **	21.42%
Milk splash	-0.41	0.19	0.03 *	15.58%
Curved shape	0.25	0.19	0.19	9.55%
Main effects - Sweetness				
Pink colour	1.51	0.21	1.56e-12 ***	58.22%
Rounded type	0.04	0.21	0.85	1.55%
Milk splash	-0.27	0.21	0.20	10.38%
Curved shape	0.78	0.23	5.69e-04 ***	29.85%
Main effects - Creaminess				
Pink colour	-0.10	0.18	0.59	6.50%
Rounded type	0.35	0.19	0.06	23.30%
Milk splash	-0.26	0.18	0.15	17.41%
Curved shape	0.80	0.19	2.16e-05 ***	52.79%
Interactions - Preference				
Colour*Type	0.02	0.28	0.92	
Colour*Splash	0.46	0.28	0.10	
Type*Splash	0.00	0.28	0.99	
Colour*Shape	0.13	0.28	0.64	
Type*Shape	0.13	0.29	0.65	
Splash*Shape	0.10	0.27	0.73	
Interactions - Sweetness				
Colour*Type	0.48	0.30	0.11	
Colour*Splash	0.92	0.30	0.02 **	
Type*Splash	0.55	0.29	0.06	
Colour*Shape	0.66	0.30	0.03 *	
Type*Shape	0.50	0.30	0.11	

Splash*Shape	0.28	0.32	0.38
Interactions - Creaminess			
Colour*Type	0.04	0.26	0.87
Colour*Splash	0.18	0.26	0.50
Type*Splash	0.06	0.26	0.81
Colour*Shape	0.24	0.26	0.36
Type*Shape	0.03	0.26	0.93
Splash*Shape	0.30	0.27	0.25

4.3.3 Word association results

The word association task collected 2,781 entries that were stemmed and grouped into 133 different word groups. The researchers consensually decided to keep some words in unitary groups, for instance, ‘cocoa’ (as an ingredient), instead of grouping this word with ‘chocolate’ (as a product), despite the semantic proximity. On the other hand, words expressing a very similar meaning were grouped together. The aim was to avoid overgrouping and an ultimate loss of information. Therefore, most groups, such as ‘sweet’, ‘milk’, ‘strawberry’, ‘bitter’, ‘creamy’, ‘mild’, ‘dark’, and ‘chocolate’, have a small or non-existent word diversity. A few groups have some word diversity, as examples: ‘tasty’ includes ‘flavourful’, ‘delicious’, and ‘pleasant’; ‘attractive’ includes ‘[I] want [it]’, ‘[I] desire [it]’, ‘[it] stands out’, ‘[I] wish [it]’, ‘[I’d] eat [it]’, and ‘[I’d] buy [it]’; ‘strong’ includes ‘intense’; and ‘hard’ also includes ‘firm’, ‘resistant’, and ‘rigid’.

Table 5 shows the 10 most used words for each sample and **Figure 4** shows the correspondence analysis factor map. The first dimension accounted for 81.28% of the data and the y-axis for 10.71%, combining to explain 91.99% together. The x-axis separates samples by colour, pink samples on the left and black samples on the right. The pink packaging samples were strongly associated with the terms ‘pink’, ‘strawberry’, and ‘childish’; the black packaging samples were strongly associated with the terms ‘strong’, ‘bitter’, and ‘dark’. The y-axis separates samples by ingredient and shape, the two samples with chocolate splash and flat shape are above, while the two samples with milk splash and curved shape are below. While the words ‘sugar’, ‘chocolate’, and ‘attractive’ are related to the two first, the words ‘milk’ and ‘simple’ were associated with the last two.

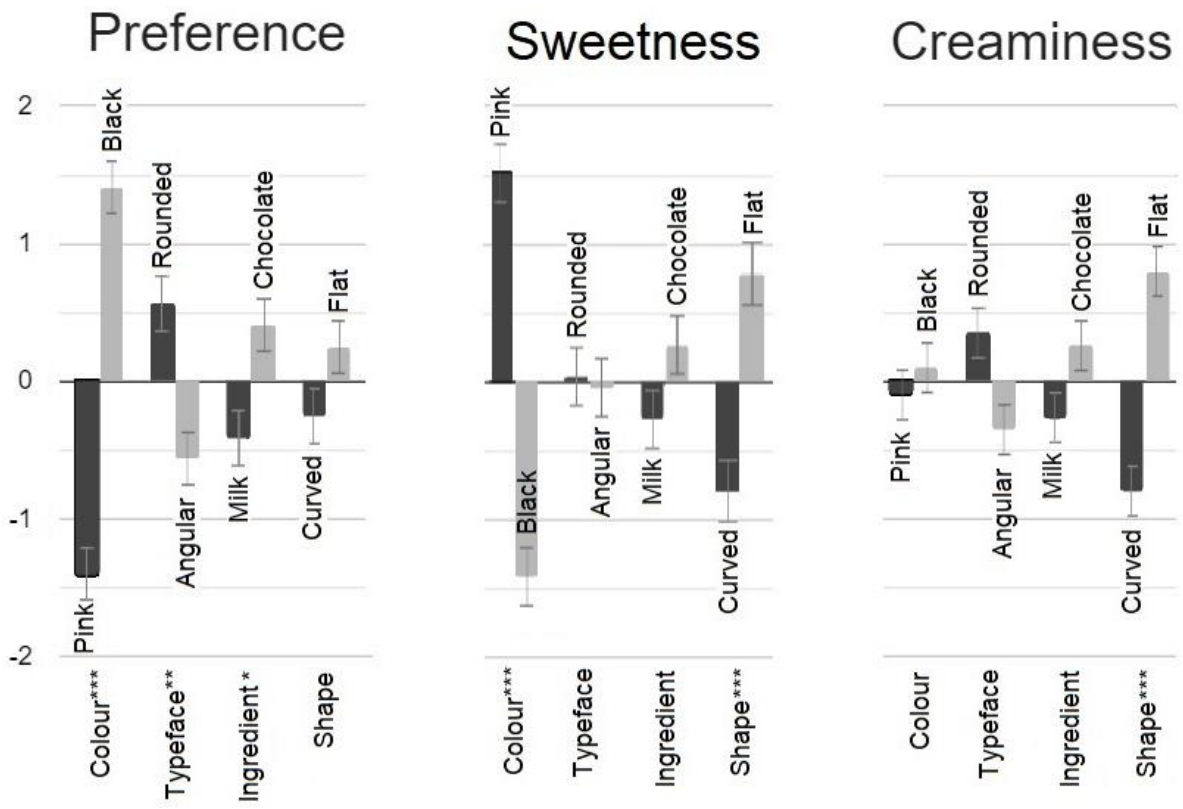

Figure 3: Estimated parameters and standard error for main effects of colour, typeface, ingredient, and shape on expected preference, sweetness, and creaminess. Variables followed by * were significant at 5%, ** at 1%, and *** at 0.1%, respectively.

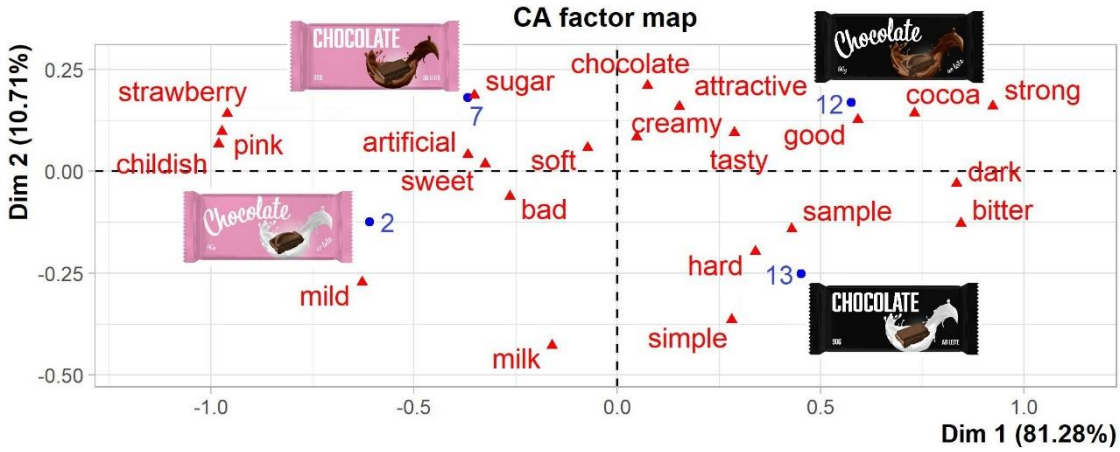

Figure 4 - Correspondence analysis factor map of the words cited at least 27 times (1% of the total entries) and the four samples evaluated on word-association task: 2 (pink/rounded/milk/curved), 7 (pink/angular/chocolate/flat), 12 (black/rounded/chocolate/curved), and 13 (black/angular/milk/flat).

Table 5 - The 10 most used groups and their frequencies for the samples 2 (pink, rounded typeface, milk splash, curved shape), 7 (pink, angular typeface, chocolate splash, flat shape), 12 (black, rounded typeface, chocolate splash, flat shape), and 13 (black, angular typeface, milk splash, curved shape).

Sample 2	**n**	**Sample 7**	**n**	**Sample 12**	**n**	**Sample 13**	**n**
Sweet	114	Sweet	110	Tasty	105	Tasty	69
Milk	86	Strawberry	75	Bitter	63	Milk	68
Strawberry	77	Tasty	58	Creamy	59	Bitter	65
Tasty	48	Creamy	53	Sweet	53	Sweet	54
Creamy	47	Chocolate	43	Strong	45	Creamy	42
Mild	30	Milk	33	Chocolate	40	Hard	28
Soft	24	Attractive	24	Milk	28	Chocolate	26
Pink	24	Pink	21	Cocoa	27	Strong	25
Chocolate	23	Hard	19	Soft	22	Attractive	18
Childish	16	Soft	17	Dark	21	Dark	16

4.4 Discussion

Regarding the first hypothesis, the results confirmed that: the participants expected the chocolate packaged in pink to be significantly sweeter than the chocolate presented in black; the chocolate in the packaging with the rounded typeface was significantly preferred over the one with angular typeface; and the curved chocolate shape made the samples look significantly sweeter and creamier than the samples displaying a flat-shaped chocolate. In addition, it was rejected that the pink packaging and the milk splash would be preferred over the black packaging and the chocolate splash, respectively.

Previous studies reported that black packaging (Ares & Deliza, 2010) and black plateware (Piqueras-Fiszman et al., 2012) may significantly reduce people's preference for desserts. Nevertheless, black packaging has already been shown to increase the expected liking of milk chocolate among participants with a similar profile to those tested here (Baptista et al., 2021). Interestingly, the latter study also found that the same black packaging was the least preferred when the chocolate was

dark, showing that the effect of packaging colour on preference depends on the type of chocolate. They argued that the black packaging might make the milk chocolate look richer in cocoa and not too sweet (Baptista et al., 2021). The preference for the chocolate in black packaging might also be explained by the profile of the participants, as they were mostly highly-educated and preferred semisweet chocolate, not reflecting the typical Brazilian preference for milk chocolate (Sebrae, 2018). These consumers might as well be influenced by the general association that has been shown to exist between black packaging and luxury/premium products (Velasco & Spence, 2019c).

The lack of significant effect of chocolate shape on expected preference contrasts with a previous study by Wang et al. (2019). Together with the significant effect of shape on creaminess and sweetness, it indicates that the participants did not initially pay attention to the shape of the chocolate (in amongst the other, possibly more salient, visual design cues). Only after they had been asked specific questions about the sensory attributes of the chocolate (creaminess and sweetness), did they instinctively search for direct cues about it and paid attention to the image of the chocolate on the front of the packaging. This behaviour contrasts with Piqueras-Fiszman et al.'s (2013) suggestion that food images draw most of a consumer's visual attention. Maybe this effect is true only for fresh/moving food or ingredients (Gvili et al., 2015; Kovač et al., 2019), but then, the milk/chocolate splash should have had a more important effect in the present study (for other null effect, see Mulier et al., 2021).

An alternative explanation for the results might be linguistic, as 'chocolate' may refer just to the foodstuff but also to the package (packaging + foodstuff). In this way, when asked 'which of the two [chocolates] would you choose?' participants evaluated which package they preferred based on packaging aesthetics. This scenario is even more probable in a completely online test, as the participants only have the packaging design as stimuli. It is relevant to note that none of the previous studies asked participants how much they liked the packaging design or even discussed the influence of aesthetics on preference.

If it is understandable that participants who like darker chocolate preferred the chocolate splash over the milk splash, it is against the authors' expectations that the milk splash did not increase the expected sweetness and creaminess, since the

addition of milk normally results in a milder, creamier, and sweeter chocolate. Yet, the preference for a chocolate splash might not be specific for the consumers that prefer darker chocolate, since a market study of mainstream brands (see **Table 1**) showed that three of them display a chocolate splash and only one displays a milk splash. The CA (**Figure 4**) may help understand why, as it indicates that the milk splash was associated with 'simple', while the chocolate splash was related to terms like 'creamy' and 'attractive'.

As for the second hypothesis (**H2**), colour was the major influence on participants' preference and sweetness expectations, adding evidence to the understanding that colour is the main attribute in a packaging (see Spence & Velasco, 2019, for a review). Many experiments that tested effects of colour hue and shape (either shape of the packaging, the background pattern or the typeface) also found similar results (Ares & Deliza, 2010; Deliza & MacFie, 2001; Matthews et al., 2019; da Rosa et al., 2019; Sousa et al., 2020a). It is interesting to note that, although tests were independent, Kovač et al. (2019) found a slightly stronger effect of image (photograph or illustration) than of colour saturation, so the dominance of colour might be more a dominance of colour hue, but not necessarily of saturation or brightness.

Regarding the word association task, the participants correlated colour with flavours ('strawberry', 'chocolate'), tastes ('sweet', 'bitter'), ingredients ('sugar', 'cocoa'), intensity ('mild', 'strong') and other concepts ('childish'). Another similar study (Ares & Deliza, 2010) has shown a stronger dominance of flavour words ('chocolate', 'vanilla', 'dulce de leche') associated to milk dessert packaging colour, possibly because their product (milk dessert) can be found with different flavours in the marketplace. Along with the results on colours and odours from Heatherly et al. (2019), it is possible to hypothesise that colour, more than correlated to tastes, is correlated to flavours. As most studies did not assess tastes and aromas together (one exception is Baptista et al., 2021), future research could evaluate how much each contributes to the crossmodal correspondence of flavour with colours.

The clear dominance of colour on preference, sweetness expectation, and word association turns the lack of significant effect of hue on expected creaminess even more interesting. This finding contributes to the idea that there may be a halo effect when the colour of a chocolate packaging affects the expected texture and

when the chocolate shape affects the expected taste (see Baptista et al., 2021; Baptista et al., 2022; Wang et al. 2019). So, a ‘sweet’ colour may well result in a chocolate that looks creamier because participants correlate sweetness with creaminess, a rounded chocolate looks sweeter because it is expected to be creamier (Ngo & Spence, 2011). Velasco et al. (2015) already discussed the indirect nature of taste and shape correspondences, arguing it could be mediated by hedonics: the rounded shapes and sweet tastes are preferred, therefore associated. This relationship might not be specific for chocolate, as Ares and Deliza (2010) also showed that the shape of milk dessert packaging was more strongly correlated with texture on the word association while the colours were more correlated to flavours.

It is possible that the presence of both independent variables (colour and shape) and both dependent variables (sweetness and creaminess) in the present study cancelled the halo effect. This would also explain why colour muffled the effects of the angular/rounded background patterns on sweet and sour taste on Matthews and colleagues’ (2019) second test. Maybe, if they (and other studies such as Ares and Deliza, 2010; Becker et al., 2011; Fairhust et al., 2015; Piqueras-Fiszman et al., 2012; da Rosa et al., 2019; Sousa et al., 2020a; Velasco et al., 2014) had also evaluated a texture attribute, the shape would not significantly affect tastes, but would influence expected texture. Contributing to this idea is that when Cadbury changed the shape of its milk chocolate from angular to rounded, one of the top complaints from consumers was that it became creamier than it used to be (Spence, 2014).

The idea that ‘colour is to taste’ what ‘shape is to texture’ could explain why packaging colour is consistently more relevant to preference than shape (see Spence & Velasco, 2019, for a review). One exception is Tijssen et al. (2017), in one of their tests the packaging colour influenced only dairy drink creaminess. One explanation is that colour had great effect on taste and liking expectations that were cancelled by contrast of two identical products. Then, if the flavour is more important for the consumer than texture in most food and beverage products (Delwiche, 2003), it is natural that the visual aspect related to flavour (colour) is more relevant to preference than the one associated with texture (shape). In the present study, it would mean that consumers are more concerned about the chocolate being filled/flavoured with strawberry or strongly bitter than if the chocolate is a bit more, or

less, creamy. That is corroborated by the spontaneous association of the pink packaging with ‘strawberry’ and the black packaging with ‘bitter’ and ‘strong’.

It would be interesting to check if these results would be reproduced in other cultures, since there is a learned dimension to the meaning of colour (Spence & Velasco, 2019; Wheatley, 1973) and Wan et al. (2014) demonstrated how taste correspondences with shapes and colours vary between cultures. Perhaps the effects of the visual variables in different cultures could be correlated to the design of popular brands in each country. As examples, the distinctive purple colour of Cadbury may have a specific effect in United Kingdom, while the angular and retro design may be more appealing for those who grew up eating Hershey’s bars in the USA, and the milk splash and curved typeface might be more important for continental Europeans used to Lindt packaging design.

The third hypothesis was mostly rejected as there were only two interactions between attributes: colour*ingredient and colour*shape, both on sweetness. Their specificity indicates that they might be more related to visibility than to integration of crossmodal effects. That is, by colour contrast, the brighter pink background makes the chocolate splash more visible and highlights the chocolate shape than the dark black packaging. Therefore, in general, participants made independent evaluations of visual cues and the global effect was a mere sum of effects (Jonas et al., 2017). This is relatable to the findings from Piqueras-Fiszman et al. (2013), since they found only one interaction, between the berry picture and the jar surface in their study. They also hypothesised that this interaction was due to attention/visibility, arguing that the ridged surface disputed the attention with the berry picture and decreased the latter’s effect.

The fourth hypothesis was confirmed, as the results found by the choice-based task were similar to previous studies that used rating tasks, indicating that the method can be used to evaluate not only preference, but also crossmodal effects of visual cues on expected taste and texture. Similar effects of colour on expected sweetness were reported by both Baptista et al. (2021) and Sugimori and Kawasaki (2022). The shape of chocolate was already shown to affect expectations of sweetness and creaminess in chocolate in studies by Wang et al. (2017) and Baptista et al. (2022). Besides the similarities already discussed with studies that tested for packaging colour and shape in other food products such as Ares and

Deliza (2010), Matthews et al. (2019), da Rosa et al. (2019), and Sousa et al. (2020a). Finally, it would be relevant to test the effects reported here on actual tasting, since packaging colour and chocolate shape have already been shown to influence post-tasting ratings of ‘tastiness’ (van Lith, 2015), tastes (Sugimori & Kawasaki, 2022; though see also Wang et al., 2017), and texture (Baptista et al, 2022).

This study was limited to popular Brazilian milk chocolate packaging, its variables and treatments, expectations stated through an online questionnaire, and mostly highly educated female Brazilian chocolate consumers.

Conclusions

This research presents three main new contributions to the literature on the visual aspects of packaging design. First, the inclusion of a texture descriptor as a dependent variable strengthened the discussion on colours being more crossmodally linked to flavours, while shapes were linked to texture. The combination of four treatments with two levels each highlights that the crossmodal effects of visual cues in chocolate packaging are mostly independent of one another, unless they happen to influence visibility. Finally, the results encourage the use of choice-based tasks to test crossmodal effects, particularly of products bought impulsively with a fast decision making process. Besides better emulating a real market situation, it requires less time and less effort from participants, allowing more complex stimuli with more variables, without giving up on a full factorial design. Further studies could include chocolate type as an independent variable, aromas as a dependent variable, test other food and beverage products and other cultures, and research how much of these effects on expectations are carried over to actual perception when consumers taste the product.

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DISCUSSÃO GERAL

Os experimentos 1 e 3 mostraram que consumidores brasileiros esperaram chocolates em formatos arredondados significativamente ($P < .05$) mais cremosos que em formatos angulares. O terceiro experimento também encontrou efeito na expectativa de doçura, sendo o chocolate curvilíneo esperado mais doce que o plano. Esses resultados dialogam diretamente com o estudo de Wang e colegas (2017), que reportou efeitos do formato nas expectativas de doçura, amargor e cremosidade de chocolates amargos entre consumidores na Bélgica. E indiretamente com diversos estudos sobre o efeito de formatos nas expectativas de gostos e texturas (VELASCO et al., 2016b).

Na discussão do primeiro experimento, considerou-se a possibilidade de formatos não serem angulares e redondos o suficiente (SALGADO-MONTEJO et al., 2015) para gerar efeito significativo nas expectativas de gosto. Isso é, as amostras usadas eram um quadrado e um círculo “bidimensionais” para não interferir na sensação bucal e para refletir o formato mais comum de consumo de chocolate, em barras. Porém, a diferença na expectativa de doçura observada no terceiro experimento indicaria que a ausência de efeito no primeiro experimento pode ser decorrente de um número pequeno de participantes (diminuindo o poder do teste) e/ou dos efeitos crossmodais terem natureza relativa (SPENCE, 2011), portanto, tendo menos força em metodologias entre grupos (between-subjects) que entre participantes (within-subjects).

No primeiro experimento também foi encontrado um efeito significativo do formato de chocolate na percepção pós-degustação de cremosidade. Embora o efeito de formato na percepção de textura de chocolates já tenha sido reportado por um estudo anterior (LENFANT et al., 2013), os chocolates usados eram desenhados biometricamente para alterar o derretimento e foram avaliados por um painel treinado. Assim, o presente estudo é provavelmente o primeiro a relatar um efeito crossmodal de formato na percepção de textura de chocolates em consumidores. O efeito já tinha sido observado ex-post-facto quando uma fabricante inglesa alterou o formato de sua barra de chocolate e recebeu reclamações de consumidores alegando diferença na doçura e cremosidade (SPENCE, 2014).

O segundo experimento revelou correlações entre as cores rosa e amarelo com maior doçura e menor amargor, e preta e verde com o inverso, corroborando pesquisas anteriores (ARES & DELIZA, 2010; CARVALHO & SPENCE, 2019; PIQUERAS-FISZMAN et al., 2012; PIQUERAS-FISZMAN & SPENCE, 2012). Em coerência com esses resultados, o terceiro experimento reforçou que a cor rosa é relacionada por crossmodalidade ao gosto doce e a cor preta é relacionada a pouca doçura. As correlações entre cores e gostos básicos já foram registradas em diversas culturas (WAN et al., 2014) e outros estudos já mostraram as associações entre cores das embalagens e as expectativas de gostos (VELASCO & SPENCE, 2019). Porém, somente um estudo anterior avaliou relações de cor e sabor em chocolate (VAN LITH, 2015) e não encontrou efeitos significativos nas expectativas de quão “gostoso” e “atrativo” o chocolate seria.

O segundo e terceiro experimentos também mostraram que uma determinada cor afeta inversamente as expectativas de aceitação de diferentes tipos de chocolate. Isto é, enquanto a embalagem rosa diminuiu a expectativa de aceitação de chocolates ao leite e aumentou a de chocolate amargo, a embalagem preta gerou efeito inverso, aumentou a aceitação esperada do chocolate ao leite e diminuiu a do amargo. A preferência pela cor preta no chocolate ao leite pode estar relacionada à percepção geral de que embalagens pretas são luxuosas (ARES & DELIZA, 2010; VELASCO & SPENCE, 2019b), mas isso não explicaria porque o chocolate amargo em embalagem preta é o menos aceito entre sete cores. É mais provável, então, que os participantes, como um grupo, preferem chocolates que pareçam balanceados, nem muito doce, nem muito amargo.

Outra discussão relevante trazida pelo segundo experimento é a insuficiência da classificação entre cores quentes e frias para explicar os efeitos crossmodais das cores de embalagens nas expectativas de gostos. Quase todos os estudos anteriores sobre o assunto compararam cores quentes e frias (ARES & DELIZA, 2010; DELIZA & MACFIE, 2001; HUANG & LU, 2015; MATTHEWS et al., 2019; REBOLLAR et al., 2012; ROSA et al., 2019; SOUSA et al., 2020a; TIJSSEN et al., 2017; VAN ESCH et al., 2019), especialmente quando se considera o preto uma cor fria, embora tecnicamente preto seja ausência de luz visível, não uma cor, e portanto, não poderia ser classificado como quente ou frio.

Em relação a correlações crossmodais entre cores e aromas, o segundo experimento mostrou que as cores de embalagens são influências mais fortes nas expectativas de aromas que o próprio tipo de chocolate (ao leite ou amargo). Ou seja, um chocolate embalado em rosa ou vermelho é esperado mais frutado que um em preto ou marrom independente do tipo. Junto com outros resultados sobre as relações entre cores e aromas (HEATHERLY et al., 2019), indicaria que mais do que ser relacionada a gostos, as cores são relacionadas a sabores. Como a maioria dos estudos anteriores perguntou por gostos ou aromas separadamente, essa relação ainda precisa ser melhor estudada.

Ngo e Spence (2011) conjecturaram que a textura pode ser mais importante para a correlação crossmodal entre formatos e chocolates. As relações cor-textura e formato-gosto podem ser indiretas, como já discutido por Velasco e colegas (2015) e Wang e colegas (2017). Para eles, uma cor “doce” pode fazer um chocolate parecer mais cremoso porque os participantes correlacionam doçura com cremosidade. Velasco e colegas (2015) ainda acrescentam que essas relações podem ser mediadas pela dimensão hedônica das características. Tanto formas redondas, quanto gosto doce são mais aceitos, portanto, seriam associados.

A conjectura de Ngo e Spence (2011) ajuda a interpretar os resultados da associação de palavras do terceiro experimento, em que os participantes relacionaram cores a sabores ("morango" e "cacau") e gostos ("doce" e "amargo"), enquanto o formato foi mais associado à textura (“duro” e “macio”). Também ajuda, em retrospecto, a interpretar os resultados de Wang e colegas (2017) e de Ares e Deliza (2010). No primeiro estudo, o formato do chocolate influenciou significativamente as expectativas de gostos e cremosidade, mas o efeito na textura teve aproximadamente o dobro de significância. Na tarefa de associação de palavras de Ares e Deliza (2010), assim como no terceiro experimento desta tese, o formato da embalagem de sobremesa láctea foi mais associada a termos relativos à textura (“espesso”, “cremoso”, “ralo”, “mole”, “aquoso”) e as cores da embalagem a gostos (“doce” e “amargo”) e aromas (“chocolate”, “doce de leite”, “caramelo”, "insosso").

A proposta de uma dicotomia entre os conjuntos cor-gosto-aroma e formato-textura pode ajudar a explicar a ideia de que a cor seja o aspecto mais importante de uma embalagem (MATTHEWS et al., 2019; SCHIFFERSTEIN, 2013; SINGH, 2006; SOUSA et al., 2020a; SPENCE & VELASCO, 2019a). As cores seriam

mais relevantes que os formatos para a aceitação porque os gostos e aromas são mais relevantes para a aceitação que a textura. Neste trabalho, significaria que os consumidores se preocupam mais com o chocolate ser saborizado de morango ou ser muito amargo do que se ele é mais ou menos cremoso.

Por fim, a semelhança dos resultados do terceiro experimento com os dois primeiros, bem como de outros anteriores (ARES & DELIZA, 2010; MATTHEWS et al., 2019; ROSA et al., 2019; SOUSA et al., 2020a; SOUSA et al., 2020b; SUGIMORI & KAWASAKI, 2022; WANG et al., 2017), indica que efeitos crossmodais podem ser medidos por tarefas de escolha. Usualmente empregado para medir preferência, o método foi usado para medir doçura e cremosidade no terceiro experimento, permitindo uma coleta de dados mais rápida e instintiva. Consequentemente, foi possível aumentar o número de amostras avaliadas por um participante, porque em vez de avaliar amostra por amostra (apresentação monádica), usando uma escala de intensidade, as amostras foram apresentadas em pares e os participantes apenas escolhiam a que lhes parecesse mais doce ou cremosa.

Em conjunto, os três experimentos desta tese mostraram que as cores estão mais associadas às expectativas de gostos, aromas e aceitação, enquanto que o formato do chocolate está mais relacionado à expectativa e à percepção de cremosidade. O primeiro e terceiro experimentos mostraram que o formato influencia majoritariamente a avaliação de textura de chocolates ao leite e amargo, já o segundo e terceiro experimentos evidenciaram que a cor da embalagem afeta principalmente as expectativas de sabores dos chocolates tanto de consumidores brasileiros, quanto franceses.

Os resultados desta tese contribuem para as pesquisas científicas sobre a experiência multissensorial de consumo de alimentos e oferecem aplicações práticas a indústrias, artesãos, designers, fotógrafos, comunicadores, vitrinistas, chefes confeiteiros, baristas e mixologistas que trabalhem com chocolate ou produtos a base de chocolate. Os recursos visuais, porém, precisam ser usados com precaução, pois diversos fatores influenciam as direções do efeito, incluindo, por exemplo, o tipo do chocolate usado. Também é preciso atenção, pois expectativas podem resultar em penalidades quando não são confirmadas (CARDELLO & SAWYER, 1992).

Dentre as limitações deste trabalho, a mais relevante é a ausência de testes sensoriais para verificar se os efeitos das embalagens nas expectativas influenciariam as percepções pós-consumo. Os experimentos também foram limitados pelos vieses dos recrutamentos, que resultaram em maior participação de jovens, do gênero feminino, altamente educados e com vínculos à FEA/Unicamp e círculos sociais dos pesquisadores, não sendo um conjunto representativo da população em geral. Em relação aos fenômenos estudados, a tese também traz uma contribuição limitada para a solução de problemas sociais, nutricionais, ambientais, econômicos ou científicos da atualidade.

Estudos futuros devem diversificar os produtos e variáveis visuais, aumentar a diversidade sociodemográfica dos participantes, incluir métodos qualitativos, reproduzir esses testes em culturas diferentes, e realizar testes sensoriais em contextos reais de consumo para verificar os efeitos reais sobre o consumo. Ainda, estudos futuros precisam explorar as origens e propriedades neurológico-culturais das relações crossmodais, e, principalmente, é necessário pesquisar formas de aplicar os efeitos descritos por essa tese em benefício da sociedade, incentivando e promovendo uma alimentação mais saudável, sustentável e acessível..

CONSIDERAÇÕES FINAIS

Os três experimentos deste trabalho mostraram que as cores de embalagem de um chocolate estão mais correlacionadas com as expectativas de gostos e aromas, enquanto que o formato do chocolate e dos elementos de sua embalagem estão mais correlacionados com a expectativa e percepção de cremosidade. A tríade cor-gosto-aroma, por sua vez, influencia quatro a cinco vezes mais a expectativa de aceitação do que a correlação formato-cremosidade. O segundo experimento também encontrou que as cores geraram efeitos parecidos em consumidores franceses e brasileiros, que a divisão das cores em quentes e frias nem sempre explicam e predizem os efeitos, e que o efeito de uma cor sobre a expectativa de aceitação pode ser inverso dependendo do tipo de chocolate. O terceiro experimento indicou que é possível medir efeitos *crossmodais* por meio de análise conjunta de tarefa baseada em escolhas, permitindo que participantes avaliem amostras de forma rápida e instintiva com resultados equivalentes a tarefas baseadas em escalas de intensidade. Esta tese contribui com o conhecimento científico sobre os efeitos de aspectos visuais no consumo multissensorial de alimentos, propõe um método inovador para avaliar efeitos *crossmodais* e oferece informações úteis a cientistas, fabricantes e designers interessados em embalagens de chocolates..

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ANEXO I - PARECER CONSUBSTANCIADO CEP

UNICAMP - CAMPUS CAMPINAS

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: Influências crossmodais de aspectos visuais na aceitação e percepção de chocolate

Pesquisador: IURI YUDI FURUKITA BAPTISTA
Área Temática:
Versão: 2
CAAE: 20489019.4.0000.5404
Instituição Proponente: Universidade Estadual de Campinas - UNICAMP
Patrocinador Principal: CONSELHO NACIONAL DE DESENVOLVIMENTO CIENTIFICO E TECNOLOGICO-CNPQ

DADOS DO PARECER

Número do Parecer: 3.645.990

Apresentação do Projeto:
Introdução: O mundo consumiu 7,3 milhões de toneladas de chocolate em 2016, representando US$98,2 bilhões em vendas. A Europa Ocidental foi responsável por US$34,4 bilhões desse mercado, os Estados Unidos da América por US$22,4 bilhões e o Brasil por US$5,5 bilhões (Conway, 2018). Para atender essa demanda, a colheita de cacau quadruplicou de pouco mais de 1 milhão de tonelada no início dos anos 1960 para 4,2 milhões nessa década. Embora seja costume citar Rozin et al. (1991) como evidência de que o chocolate é um dos alimentos mais desejados pelos ocidentais, é melhor indício disso que, nos EUA, país que mais consome esse produto, o volume de vendas de confeitos com chocolate seja o dobro da soma de todos os outros confeitos (Gaille, 2019). Se por um lado o chocolate é um alimento de alto teor calórico, rico em gordura e açúcar, por outro ele é fonte de minerais dietéticos - como ferro, cobre, magnésio, zinco, fósforo - e flavonóides antioxidantes e antiinflamatórios (Seem et al., 2019). Essas características fazem seu consumo frequente ser relacionado tanto à obesidade e ao aumento de triglicerídios e colesterol séricos (Sokolov et al., 2013; Varonese et al., 2019), quanto à diminuição de níveis de estresse, genotoxicidade celular, osteoporose e pressão arterial, bem como à melhora da sensibilidade à insulina, da capilaridade sanguínea cerebral e do metabolismos lipídico e glicolítico (Grassi et al., 2015; Levya-Soto et al., 2018; Rees et al., 2018). Uma vez que a presença dos compostos bioativos benéficos à saúde humana é diretamente proporcional à concentração de

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cacau (Vinson et al., 1999), torna-se de interesse público aumentar a proporção desse ingrediente nos chocolates disponíveis aos consumidores. Porém, a resposta psicoativa e a quantidade ingerida por consumidores tendem a aumentar diretamente proporcionais à concentração de açúcar adicionado na formulação (Casperson, 2019). Assim, torna-se um desafio incrementar o teor de compostos bioativos aumentando a proporção de cacau em relação ao açúcar sem que haja perda de aceitabilidade em chocolates. O presente projeto de pesquisa aborda o tema pelo viés do formato do chocolate e da cor da embalagem na expectativa e percepção desse confeito. Algumas características do produto e de seu consumo o tornam ideal para esse viés, tais como: a facilidade técnica de moldar o chocolate; a venda e consumo habitualmente diretos no formato e na embalagem de fabricação; a inexistência de um formato ou cor de embalagem usualmente associados; o consumo mundial três vezes maior do ao leite em relação ao amargo (Conway, 2016), tornando relevante o desenvolvimento de estratégias que elevem o percentual de cacau usualmente aceito pelos consumidores. Foi encontrado nenhum estudo avaliando especificamente o efeito da cor da embalagem de chocolates, porém sabe-se que a cor dos alimentos em si (Spence, 2019), a cor externa da embalagem (Piqueras-Fiszman & Spence, 2015; Spence, 2018), do interior da embalagem (van Esch, 2019), do recipiente (Piqueras-Fiszman et al., 2012) e do ambiente (Oberfeld et al., 2009; Cho et al., 2015) afetam a percepção do consumidor quanto à intensidade dos atributos do alimento, sua identidade, qualidade, potencial de saciedade, propriedades hedônicas, emoções provocadas (Merlo et al, 2018) e também sua quantidade consumida até a saciação. Um dos primeiros trabalhos sobre o tema testou embalagens de suco de maracujá em consumidores que não conheciam o produto (Deliza, 1996 apud Deliza & MacFie, 2001). A cor da caixa (laranja ou branca) influenciou principalmente a expectativa de doçura e acidez, mas também aceitação, frescor, refrescância, pureza e percepção de naturalidade. Posteriormente, Ares & Deliza (2010) publicaram trabalho com sobremesas lácteas em potes redondos, quadrados, amarelos, brancos e/ou pretos. Para os consumidores uruguaios, a cor amarela remeteu a doce de leite e a cor preta a refinamento. Puyares et al. (2010) encontraram o formato e cor de garrafa ideais para um vinho tinto, algo parecido com o que fizeram depois Lunardo e Livat (2016) para o formato e cor do rótulo de um vinho rosé. Piqueras-Fiszman & Spence (2011) relataram que a cor da embalagem de batata chips influencia na identificação do sabor, mas não na aceitação. Já Rebollar et al. (2012) testaram embalagens de goma de mascar em diferentes cores e formatos com consumidores online e reportaram que as cores são relevantes na expectativa de sabor, gosto e aceitação dos produtos. Huang & Lu (2015) pesquisaram embalagens digitalmente modificadas de cereal matinal, sorvete, chá gelado e iogurte nas cores

vermelha, verde e azul, descobrindo que a primeira gera consistentemente a expectativa de um produto mais doce e menos saudável. As expectativas geradas por embalagens vermelhas ou azuis de linguiça light e bebida láctea com menos açúcar variam conforme a saturação das cores (Tijssen et al., 2017). O iogurte é esperado e percebido mais doce, cremoso e intenso em embalagem vermelha. A linguiça é esperada, mas não percebida, mais gorda e de sabor mais intenso na vermelha. A ausência de alteração significativa na percepção poderia ser oriunda da distância entre a embalagem e o consumo da linguiça, ou seja, não se come direto da embalagem (Schifferstein et al., 2013). O brilho teve efeitos inversos entre os dois produtos, sendo que mais brilho diminuiu a expectativa de doçura no iogurte e aumentou a expectativa de sabor na linguiça. Zellner et al. (2018) também não encontraram diferença significativa na percepção de balas em embalagens de cores diferentes, embora sejam colocadas na boca diretamente da embalagem e tenham gerado expectativas diferentes. A possível causa para a ausência de mudanças significativas na percepção é que as balas tinham sabor insosso demais por serem apenas açúcar puxado. De acordo com a teoria da assimilaçãocontraste (Sherif et al., 1958), a interação entre expectativa e percepção pode resultar em assimilação ou contraste. Se a percepção for próxima à expectativa, a tendência é que o cérebro aproxime a percepção da expectativa; por outro lado, se a diferença é grande demais para ser assimilada, ocorre o inverso, por contraste, as pessoas exacerbam a diferença entre expectativa e percepção. Em relação aos formatos, há consenso na literatura quanto às interações crossmodais entre eles, palavras e gostos: formas arredondadas, gosto doce e as palavras bouba/maluma/lula estão relacionadas assim como formas angulares, as palavras kiki/takete/tuki e os gostos amargo e ácido (Spence et al., 2013; Velasco et al., 2014; Salgado-Montejo et al., 2015, Velasco et al., 2016b). No primeiro grupo, ainda se pode acrescentar melhor aceitação hedônica e simetria, bem como pior aceitação e assimetria ao segundo grupo (Velasco et al., 2015; Velasco et al., 2016a, Turoman et al., 2018). Além disso, as correlações valem também para combinações como um círculo e um quadrado representarem o gosto agridoce (Velasco et al., 2018). Pesquisas avaliando a capacidade de estímulos visuais influenciarem a percepção são recentes. Primeiro, Liang et al. (2013) relataram ser possível alterar a percepção de intensidade de doçura em soluções de açúcar por meio de estímulos visuais mostrados imediatamente antes da degustação. O efeito é muito claro na concentração 3,1 g/L, mas não nas 1,5 ou 3,9 g/L. A diminuição da percepção de dulçor ao ver uma estrela antes de provar a solução 3,1 g/L é mais significativa que o aumento gerado por formatos redondos (Liang et al., 2013). Recentemente, servindo bebida láctea sabor morango e bebida cafeinada à base de mate em recipientes transparentes angular ou redondo, Machiels (2018) encontrou efeito significativo apenas no

aumento da percepção de amargor do mate quando consumido no recipiente cúbico. Dois estudos sobre a influência do formato na percepção de chocolate não encontraram correlação entre formato e percepção de gosto, embora um deles tenha perguntado e encontrado diferenças na percepção de textura e sabores (Lefant et al., 2013; Wang et al., 2017). Em ambas, porém, foram utilizados apenas chocolates de alto teor de cacau (70%, 75% e 80%), justificando a realização de um experimento com teores menores conforme será detalhado posteriormente. Experimentos com outros alimentos indicam que o formato do produto em si, de seu recipiente e de imagens vistas antes do consumo podem alterar a expectativa, percepção e consumo deles (Deroy & Valentin, 2011; Liang et al. 2013; Machiels, 2018). Os resultados de Wang et al. (2017) e Machiels (2018) podem ser compreendidos sob a luz da teoria da assimilação-contraste (Sherif et al., 1958) que indica que a interação entre expectativa e percepção pode resultar em assimilação ou contraste dependendo da diferença entre elas. Se a percepção for próxima à expectativa, a tendência psicológica é que o cérebro aproxime a percepção da expectativa; quando a diferença é grande demais para ser assimilada, ocorre o inverso, por contraste, a percepção exacerba a diferença. Assim, a bebida láctea pode ter sido doce demais e o chocolate amargo demais para ocorrer incorporação de expectativa, houve, pelo contrário, uma quebra de expectativa.

Hipótese: O formato do chocolate e a cor da embalagem alteram a expectativa do consumidor quanto às características do chocolate; a expectativa, por sua vez, modulam a percepção gustativa e somatossensorial do confeito.

Metodologia Proposta: Experimento 1 - Formato Serão recrutados 360 consumidores de chocolate voluntários por meio de cartazes em murais da Unicamp e postagens no grupo "Unicamp" no Facebook. Entre as 10h e 16h de dois dias consecutivos, serão recebidos no Laboratório de Ciência Sensorial e Estudo do Consumidor (LCSEC) da FEA/Unicamp. Eles serão convidados a avaliar 10 amostras diferentes de chocolate: cinco formulações (30%, 40%, 50%, 60%, 70%) em formato redondo e quadrado. Elas serão avaliadas em bloco incompleto com apresentação monádica balanceada entre os assessores por meio do software Compusense Cloud (Compusense, Ontário, Canadá) de acordo com a ISO 13299:2016 (ISO, 2016). Nos computadores das cabines do LCSEC, os voluntários devem ler o TCLE, caso concordem, receberão por e-mail uma cópia do termo e serão convidados a responder a uma pesquisa demográfica e de padrão de consumo de chocolate. O avaliador receberá então a primeira amostra de chocolate. Apenas olhando a amostra, ele será instruído a avaliar a expectativa de intensidade de doçura, amargor e cremosidade, a expectativa

de aceitação hedônica em escala de 9 pontos estruturada. Em seguida, ele será convidado a comer a amostra e avaliar a intensidade percebida de doçura, amargor e cremosidade, bem como a aceitação hedônica e, em escala de ideal, o qual parecido é com o chocolate que costuma consumir. Experimento 2 - Pré-teste cor da embalagem Serão recrutados 480 consumidores de chocolate brasileiros por meio de publicações em grupos de Facebook relativos à Unicamp e perfis pessoais dos pesquisadores. Os voluntários serão convidados a participar da pesquisa usando seus próprios dispositivos com acesso à internet, bastando acessar um formulário online disponibilizado na plataforma Compusense Cloud. Caso concordem com o TCLE, recebem uma cópia por e-mail e são convidados a responder as mesmas pesquisas demográfica e de padrão de consumo do Experimento 1. Em seguida, serão apresentadas, uma por vez, imagens de bombons embalados em papel chumbo nas cores branca, amarela, verde, azul, vermelho, rosa, marrom e preto. Os consumidores serão instruídos a avaliar a expectativa de intensidade de doçura, amargor, cremosidade e aceitação global de cada chocolate em uma escala não estruturada de 9 pontos. Experimento 3 - Cor da embalagem - Serão recrutados 240 consumidores de chocolate pelos mesmos meios que do Experimento 1. Entre as 10h e 16h de dois dias consecutivos, serão recebidos no LCSEC. Eles serão convidados a avaliar, em bloco completo com apresentação monádica balanceada, a combinação de 2 formulações embaladas em 2 cores diferentes, totalizando 4 amostras. A formulações utilizadas serão: a que tiver intensidade de doçura e amargor percebidas como mais parelhas no Experimento 1; e a formulação que for considerada mais parecida com o que os consumidores habitualmente consomem. As cores utilizadas serão: a que gerar expectativa de mais doçura e a que gerar expectativa de mais amargor no Experimento 2. Nos computadores das cabines, lerão o TCLE. Caso concordem com o termo, recebem um cópia por e-mail e respondem a mesma pesquisa demográfica e sobre consumo de chocolate do Experimento 1. O avaliador receberá então a primeira amostra de chocolate. Apenas a observando, ele será instruído a avaliar a expectativa de intensidade de doçura, amargor e cremosidade, a expectativa de aceitação hedônica em escala de 9 pontos estruturada. Em seguida, ele será convidado a comer a amostra e avaliar a intensidade percebida de doçura, amargor e cremosidade, bem como a aceitação hedônica e, em escala de ideal, o qual parecido é com o chocolate que costuma consumir. Análise estatística - Os dados de todos os experimentos serão analisados estatisticamente por Multi-Way Analysis of Variance (Manova). Os experimentos 1 e 2 também serão analisados pelo Teste de Tukey. Ambos serão realizados em RStudio (versão Desktop 1.2.1335, RStudio, Boston, EUA).

Critério de Inclusão: Indivíduos com idades entre 18 e 60 anos que consumam regularmente chocolate (pelo menos 1 vez por mês) e estejam em plena capacidade sensorial.

Critério de Exclusão: Indivíduos alérgicos, intolerantes ou com restrição aos ingredientes utilizados nas formulações das amostras (cacau, açúcar, leite, gordura vegetal e lecitina de soja) ou que relatem estar com sua capacidade sensorial comprometida por doença ou uso de medicamentos.

Metodologia de Análise de Dados: Os dados de todos os experimentos serão analisados estatisticamente por Multi-Way Analysis of Variance (Manova). Os experimentos 1 e 2 também serão analisados pelo Teste de Tukey. Ambos serão realizados em RStudio (versão Desktop 1.2.1335, RStudio, Boston, EUA).

Desfecho Primário: O formato do chocolate e a cor da embalagem alteram a expectativa do consumidor quanto às características do chocolate; a expectativa, por sua vez, modulam a percepção gustativa e somatossensorial do confeito.

Objetivo da Pesquisa:

Objetivo primário: Avaliar a influência do formato na expectativa e percepção de cinco formulações de chocolate com diferentes teores de cacau; Avaliar a influência da cor da embalagem na expectativa e percepção de duas formulações de chocolates com diferentes teores de cacau; Analisar os dados relacionando perfis demográficos, perfis de consumo de chocolate, formulações, expectativa, percepção, formatos de chocolate e cores de embalagem.

Avaliação dos Riscos e Benefícios:

Segundo informações dos pesquisadores, os riscos estão relacionados a possíveis desconfortos causados por alergias e intolerâncias aos ingredientes das amostras: cacau, açúcar, leite, gordura vegetal e lecitina de soja. Os participantes também poderão sentir algum desconforto no momento do teste se não gostarem do sabor do produto testado. Quanto aos benefícios, menciona-se que o participante não terá custos, nem receberá qualquer recompensa financeira. O benefício indireto ao participar dessa pesquisa é contribuir para o desenvolvimento da área de Ciência Sensorial e Estudo do Consumidor.

Comentários e Considerações sobre a Pesquisa:

Este protocolo se refere ao Projeto de Pesquisa intitulado "Influências crossmodais de aspectos

visuais na aceitação e percepção de chocolate", cujo Pesquisador responsável é doutorando Iuri Yudi Furukita Baptista, sob orientação do Prof. Dr. Jorge Herman Behrens. Faz também parte da equipe de pesquisa Priscilla Efraim. A pesquisa foi enquadrada na "Grande Área Alimentos" e tem por objetivo avaliar a influência do formato na expectativa e percepção de cinco formulações de chocolate com diferentes teores de cacau. Segundo as Informações Básicas do Projeto, a pesquisa tem orçamento de R$ 2.601,96 (dois mil seiscentos e um reais e noventa e seis centavos), custeado pelo CONSELHO NACIONAL DE DESENVOLVIMENTO CIENTIFICO E TECNOLOGICO-CNPQ. O cronograma apresentado contempla início da coleta de dados para novembro de 2019, e serão abordados 1080 consumidores adultos, recrutados na UNICAMP e em mídias sociais.

Considerações sobre os Termos de apresentação obrigatória:

Foram apresentados todos os documentos de apresentação obrigatória, a saber: Folha de Rosto Para Pesquisa Envolvendo Seres Humanos; Comprovação do vínculo com a Universidade Estadual de Campinas (UNICAMP); Currículo do pesquisador principal e demais colaboradores; Projeto de Pesquisa; Orçamento financeiro e fontes de financiamento; Cronograma; Termo de Consentimento Livre e Esclarecido. Foram analisados ainda os documentos "CartaResposta.pdf", "TextosRecrutamentoRedesSociais.pdf", e "CartazRecrutamento.pdf". Nesta versão do protocolo, foram apresentadas versões corrigidas do Projeto de Pesquisa e TCLE, respondendo às pendências apontadas no parecer anterior.

Recomendações:

Para futuras submissões sugerimos que os pesquisadores apresentem uma versão mais resumida da introdução na Plataforma Brasil, pois todo o texto que lá consta deve ser incluído no parecer, deixando o mesmo muito extenso.

Conclusões ou Pendências e Lista de Inadequações:

Nesta versão do protocolo, todas as pendências e inadequações foram respondidas adequadamente.

Considerações Finais a critério do CEP:

- O participante da pesquisa deve receber uma via do Termo de Consentimento Livre e Esclarecido, na íntegra, por ele assinado (quando aplicável).

- O participante da pesquisa tem a liberdade de recusar-se a participar ou de retirar seu consentimento em qualquer fase da pesquisa, sem penalização alguma e sem prejuízo ao seu cuidado (quando aplicável).

- O pesquisador deve desenvolver a pesquisa conforme delineada no protocolo aprovado. Se o pesquisador considerar a descontinuação do estudo, esta deve ser justificada e somente ser realizada após análise das razões da descontinuidade pelo CEP que o aprovou. O pesquisador deve aguardar o parecer do CEP quanto à descontinuação, exceto quando perceber risco ou dano não previsto ao participante ou quando constatar a superioridade de uma estratégia diagnóstica ou terapêutica oferecida a um dos grupos da pesquisa, isto é, somente em caso de necessidade de ação imediata com intuito de proteger os participantes.

- O CEP deve ser informado de todos os efeitos adversos ou fatos relevantes que alterem o curso normal do estudo. É papel do pesquisador assegurar medidas imediatas adequadas frente a evento adverso grave ocorrido (mesmo que tenha sido em outro centro) e enviar notificação ao CEP e à Agência Nacional de Vigilância Sanitária – ANVISA – junto com seu posicionamento.

- Eventuais modificações ou emendas ao protocolo devem ser apresentadas ao CEP de forma clara e sucinta, identificando a parte do protocolo a ser modificada e suas justificativas e aguardando a aprovação do CEP para continuidade da pesquisa. Em caso de projetos do Grupo I ou II apresentados anteriormente à ANVISA, o pesquisador ou patrocinador deve enviá-las também à mesma, junto com o parecer aprovatório do CEP, para serem juntadas ao protocolo inicial.

- Relatórios parciais e final devem ser apresentados ao CEP, inicialmente seis meses após a data deste parecer de aprovação e ao término do estudo.

-Lembramos que segundo a Resolução 466/2012 , item XI.2 letra e, "cabe ao pesquisador apresentar dados solicitados pelo CEP ou pela CONEP a qualquer momento".

-O pesquisador deve manter os dados da pesquisa em arquivo, físico ou digital, sob sua guarda e responsabilidade, por um período de 5 anos após o término da pesquisa.

Este parecer foi elaborado baseado nos documentos abaixo relacionados:

Tipo Documento	Arquivo	Postagem	Autor	Situação

Informações Básicas do Projeto	PB_INFORMAÇÕES_BÁSICAS_DO_PROJETO_1408794.pdf	07/10/2019 17:38:24		Aceito
Outros	TextosRecrutamentoRedesSociais.pdf	07/10/2019 17:37:43	IURI YUDI FURUKITA BAPTISTA	Aceito
Outros	CartaResposta.pdf	07/10/2019 17:37:13	IURI YUDI FURUKITA BAPTISTA	Aceito
Outros	CartazRecrutamento.pdf	07/10/2019 17:36:47	IURI YUDI FURUKITA BAPTISTA	Aceito
Projeto Detalhado / Brochura Investigador	ProjetoCEP.pdf	07/10/2019 17:35:54	IURI YUDI FURUKITA BAPTISTA	Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	TCLE_Experimento3.pdf	07/10/2019 17:34:45	IURI YUDI FURUKITA BAPTISTA	Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	TCLE_Experimento2.pdf	07/10/2019 17:34:36	IURI YUDI FURUKITA BAPTISTA	Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	TCLE_Experimento1.pdf	07/10/2019 17:34:13	IURI YUDI FURUKITA BAPTISTA	Aceito
Folha de Rosto	FolhaRosto.pdf	10/09/2019 21:23:23	IURI YUDI FURUKITA BAPTISTA	Aceito
Declaração do Patrocinador	RendimentosCNPQ.pdf	10/09/2019 21:17:27	IURI YUDI FURUKITA BAPTISTA	Aceito
Declaração de Pesquisadores	ComprovanteVinculo.pdf	10/09/2019 21:13:10	IURI YUDI FURUKITA BAPTISTA	Aceito

Situação do Parecer:
Aprovado

Necessita Apreciação da CONEP:
Não

CAMPINAS, 17 de Outubro de 2019

Assinado por:
Renata Maria dos Santos Celeghini
(Coordenador(a))

Endereço: Rua Tessália Vieira de Camargo, 126
Bairro: Barão Geraldo **CEP:** 13.083-887
UF: SP **Município:** CAMPINAS
Telefone: (19)3521-8936 **Fax:** (19)3521-7187 **E-mail:** cep@fcm.unicamp.br

ANEXO II - PERMISSÃO DE REPRODUÇÃO *BRITISH FOOD JOURNAL*

11 February 2022

"The shape of creaminess: consumers expected and perceived rounded chocolates as creamier than squared" published 7 October 2021 in British Food Journal, ahead of print

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ANEXO III - PERMISSÃO DE REPRODUÇÃO *INT. J. GASTR. FOOD SCI.*

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Iuri Yudi Furukita Baptista <i211255@dac.unicamp.br>

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RE: Effects of packaging color on expected flavor, texture, and liking of chocolate in Brazil and France, International Journal of Gastronomy and Food Science, Volume 24, July 2021, Baptista et al

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ANEXO IV - SUBMISSÃO *JOURNAL OF SENSORY STUDIES*

Gmail Iuri Baptista <iuri.baptista@gmail.com>

Journal of Sensory Studies - Manuscript ID JOSS-OGA-22-0100 [email ref: SE-6-a]
1 mensagem

Priya Rajan <onbehalfof@manuscriptcentral.com> 22 de junho de 2022 07:50
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Cc: iuri.baptista@gmail.com, CHARLES.SPENCE@psy.ox.ac.uk, r942466@dac.unicamp.br, eric.ferreira@unifal-mg.edu.br, behrens@unicamp.br

22-Jun-2022

Dear Mr. Yudi Furukita Baptista:

Your manuscript entitled "Colour is to flavour as shape is to texture: A choice-based conjoint study of visual cues on chocolate packaging" by Yudi Furukita Baptista, Iuri; Spence, Charles; Shimizu, Renata; Ferreira, Eric; Behrens, Jorge, has been successfully submitted online and is presently being given full consideration for publication in Journal of Sensory Studies.

Co-authors: Please contact the Editorial Office as soon as possible if you disagree with being listed as a co-author for this manuscript.

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Thank you for submitting your manuscript to Journal of Sensory Studies.

Sincerely,
Journal of Sensory Studies Editorial Office

ANEXO V – QUESTIONÁRIOS EXPERIMENTO 1

Questionário de expectativa (pré-consumo)

O quão doce você acha que esse chocolate é?
Nada doce □ □ □ □ □ □ □ □ □ Muitíssimo doce

O quão amargo você acha que esse chocolate é?
Nada amargo □ □ □ □ □ □ □ □ □ Muitíssimo amargo

O quão cremoso você acha que esse chocolate é?
Nada cremoso □ □ □ □ □ □ □ □ □ Muitíssimo cremoso

Como um todo, o quanto você acha que gostará do chocolate?
Desgostarei muitíssimo □ □ □ □ □ □ □ □ □ Gostarei muitíssimo

Questionário de percepção (pós-consumo)

O quão doce você acha que esse chocolate é?
Nada doce □ □ □ □ □ □ □ □ □ Muitíssimo doce

O quão amargo você acha que esse chocolate é?
Nada amargo □ □ □ □ □ □ □ □ □ Muitíssimo amargo

O quão cremoso você acha que esse chocolate é?
Nada cremoso □ □ □ □ □ □ □ □ □ Muitíssimo cremoso

Como um todo, o quanto você acha que gostará do chocolate?
Desgostarei muitíssimo □ □ □ □ □ □ □ □ □ Gostarei muitíssimo

Questionário demográfico e de padrão de consumo de chocolate

Idade: _____

Gênero:
□ Feminino
□ Masculino
□ Outro: _____

Última/atual escolaridade, completa ou não:
□ Fundamental
□ Médio
□ Graduação

□ Pós-graduação

Que tipo de chocolate costuma consumir:
□ Branco
□ Ao leite
□ Meio amargo
□ Amargo

Quantas vezes come chocolate por mês:
□ 1 a 4
□ 5 a 8
□ 8 a 12
□ Mais de 12

ANEXO VI – QUESTIONÁRIOS EXPERIMENTO 2

O quão doce você acha que esse chocolate é?
Nada doce □ □ □ □ □ □ □ □ □ Muitíssimo doce

O quão amargo você acha que esse chocolate é?
Nada amargo □ □ □ □ □ □ □ □ □ Muitíssimo amargo

O quão cremoso você acha que esse chocolate é?
Nada cremoso □ □ □ □ □ □ □ □ □ Muitíssimo cremoso

O quão frutado você acha que esse chocolate é?
Nada frutado □ □ □ □ □ □ □ □ □ Muitíssimo frutado

Como um todo, o quanto você acha que gostará do chocolate?
Desgostarei muitíssimo □ □ □ □ □ □ □ □ □ Gostarei muitíssimo

Questionário demográfico e de padrão de consumo de chocolate

Idade: _____

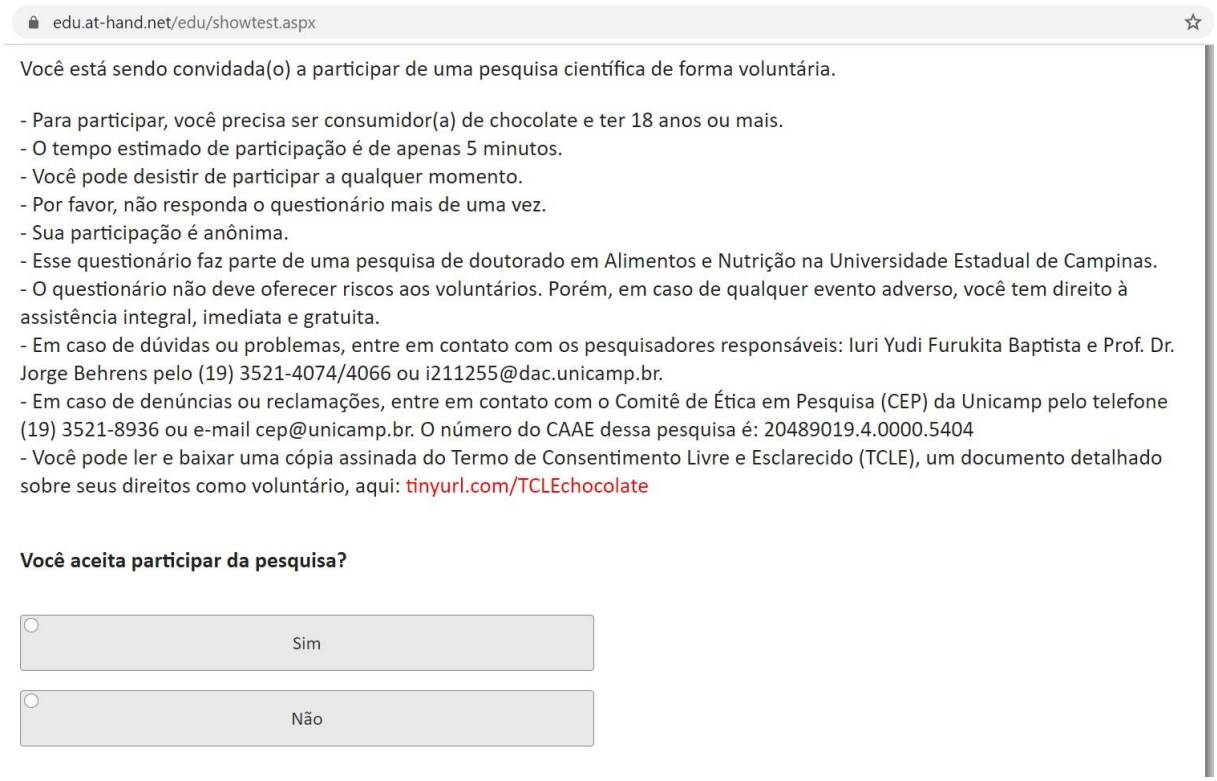
Gênero:
□ Feminino
□ Masculino
□ Outro: _____

Última/atual escolaridade, completa ou não:
□ Fundamental
□ Médio
□ Graduação
□ Pós-graduação

Que tipo de chocolate costuma consumir:
□ Branco
□ Ao leite
□ Meio amargo
□ Amargo

Quantas vezes come chocolate por mês:
□ 1 a 4
□ 5 a 8
□ 8 a 12
□ Mais de 12

ANEXO VII – QUESTIONÁRIOS EXPERIMENTO 3


edu.at-hand.net/edu/showtest.aspx

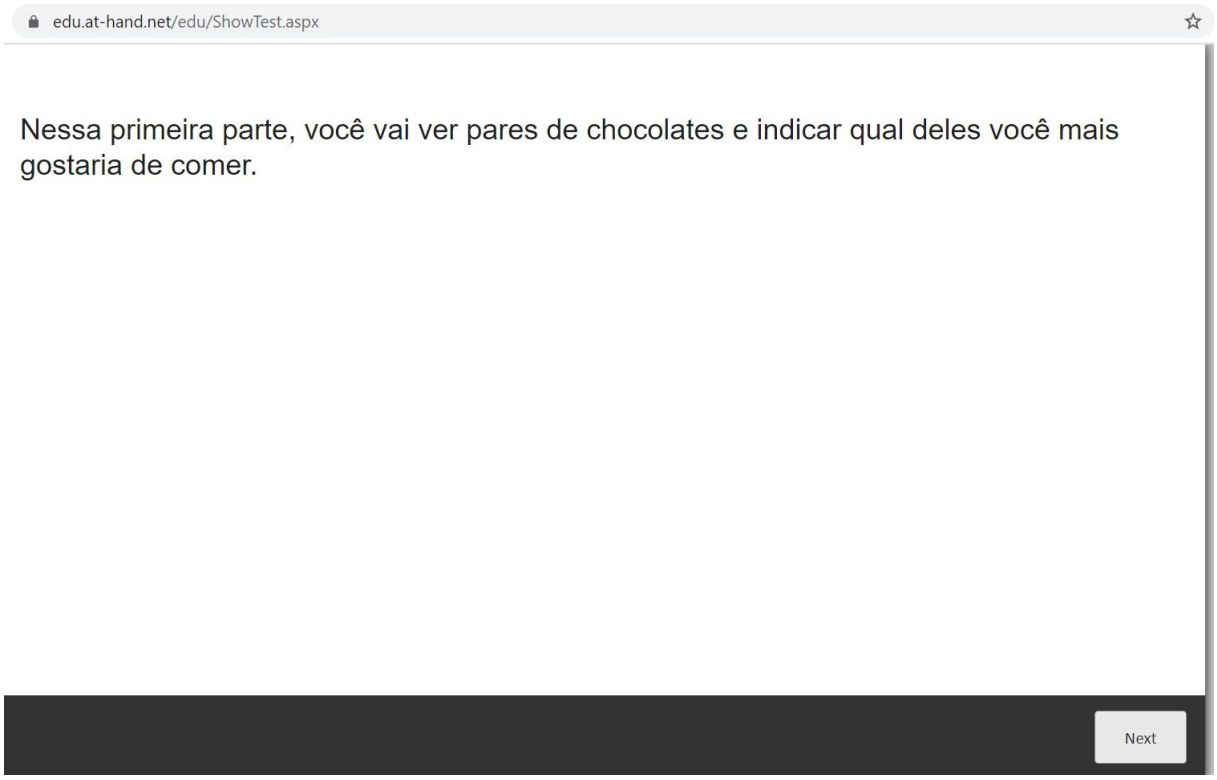
Você está sendo convidada(o) a participar de uma pesquisa científica de forma voluntária.

- Para participar, você precisa ser consumidor(a) de chocolate e ter 18 anos ou mais.
- O tempo estimado de participação é de apenas 5 minutos.
- Você pode desistir de participar a qualquer momento.
- Por favor, não responda o questionário mais de uma vez.
- Sua participação é anônima.
- Esse questionário faz parte de uma pesquisa de doutorado em Alimentos e Nutrição na Universidade Estadual de Campinas.
- O questionário não deve oferecer riscos aos voluntários. Porém, em caso de qualquer evento adverso, você tem direito à assistência integral, imediata e gratuita.
- Em caso de dúvidas ou problemas, entre em contato com os pesquisadores responsáveis: Iuri Yudi Furukita Baptista e Prof. Dr. Jorge Behrens pelo (19) 3521-4074/4066 ou i211255@dac.unicamp.br.
- Em caso de denúncias ou reclamações, entre em contato com o Comitê de Ética em Pesquisa (CEP) da Unicamp pelo telefone (19) 3521-8936 ou e-mail cep@unicamp.br. O número do CAAE dessa pesquisa é: 20489019.4.0000.5404
- Você pode ler e baixar uma cópia assinada do Termo de Consentimento Livre e Esclarecido (TCLE), um documento detalhado sobre seus direitos como voluntário, aqui: tinyurl.com/TCLEchocolate

Você aceita participar da pesquisa?

Sim

Não


edu.at-hand.net/edu/ShowTest.aspx

Nessa primeira parte, você vai ver pares de chocolates e indicar qual deles você mais gostaria de comer.

Next

edu.at-hand.net/edu/ShowTest.aspx

Qual desses dois chocolates você escolheria?

- O de cima
- O de baixo

Next

edu.at-hand.net/edu/ShowTest.aspx

Agora, você vai ver um chocolate e escrever as 3 primeiras palavras que vierem a sua cabeça.

Next

edu.at-hand.net/edu/ShowTest.aspx

Em relação a esse chocolate, escreva as 3 primeiras palavras que vierem a sua cabeça:

Next

edu.at-hand.net/edu/ShowTest.aspx

Agora, você vai ver pares de chocolates e indicar qual deles você acha que é o mais **doce** e qual é o mais **cremoso**. Não existem respostas certas e erradas, estamos interessados na sua impressão.

Next

edu.at-hand.net/edu/ShowTest.aspx

Qual desses dois chocolates você acha que é o mais **doce**?

- O de cima
- O de baixo

Qual desses dois chocolates você acha que é o mais **cremoso**?

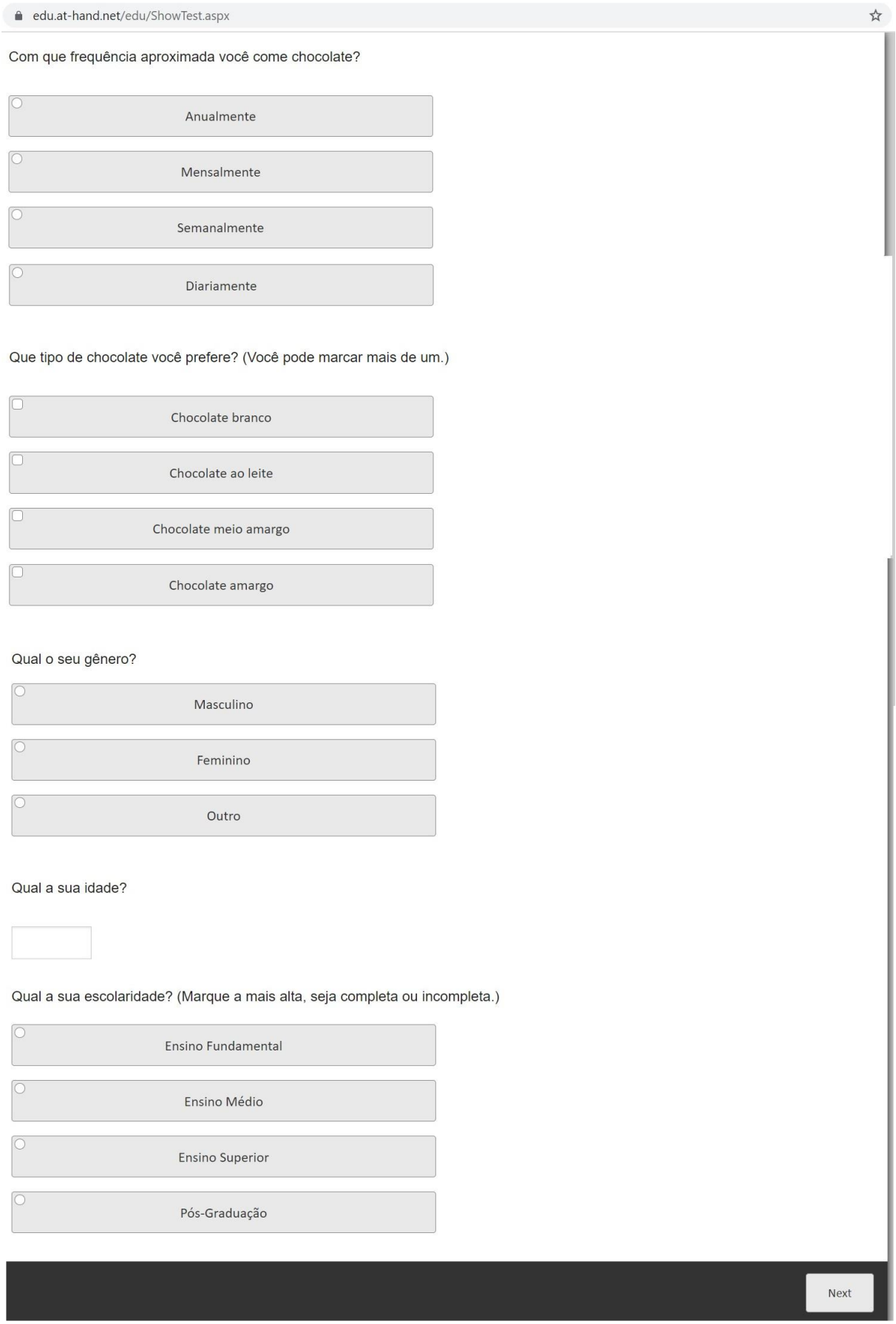
- O de cima
- O de baixo

Next

edu.at-hand.net/edu/ShowTest.aspx

Nessa última parte, vamos fazer algumas perguntas sobre você para entender melhor os resultados.

Next


edu.at-hand.net/edu/ShowTest.aspx
Com que frequência aproximada você come chocolate?
Anualmente
Mensalmente
Semanalmente
Diariamente
Que tipo de chocolate você prefere? (Você pode marcar mais de um.)
Chocolate branco
Chocolate ao leite
Chocolate meio amargo
Chocolate amargo
Qual o seu gênero?
Masculino
Feminino
Outro
Qual a sua idade?
Qual a sua escolaridade? (Marque a mais alta, seja completa ou incompleta.)
Ensino Fundamental
Ensino Médio
Ensino Superior
Pós-Graduação
Next