Clever people: Intelligence and humor production ability

By: Alexander P. Christensen, Paul J. Silvia, Emily C. Nusbaum, and Roger E. Beaty

Christensen, A. P., Silvia, P. J., Nusbaum, E. C., & Beaty, R. E. (2018). Clever people: Intelligence and humor production ability. *Psychology of Aesthetics, Creativity, and the Arts, 12*(2), 136-143.

Abstract:

Are smarter people funnier? Recent work suggests that cognitive abilities are important to humor production—the ability to generate funny ideas on the spot. Using the Cattell–Horn–Carroll model of intelligence, the present research examined both general and specific contributions of cognitive factors to humor ability. It extended past research by (a) measuring a broader range of cognitive abilities, including some that have not been assessed thus far, (b) assessing humor with a broader battery of tasks, and (c) using bifactor models to estimate both general and specific effects of intelligence on humor. A sample of 270 young adults completed measures of fluid reasoning (Gf), vocabulary knowledge (Gc), and broad retrieval ability (Gr) along with a battery of humor production tasks. All 3 specific factors correlated with humor ability, and a higher order model found a large effect of *g* on humor ability ($\beta = .51$ [.32, .70]). In a bifactor model, however, humor ability was predicted primarily by g and Gr but not Gf, suggesting that fluid intelligence's correlation with humor ability found in past studies is carried by *g*. These findings illustrate both general and specific effects of intelligence on humor, and they expand the growing literature on the important role of intelligence in creative thought.

Keywords: humor | intelligence | creativity | reasoning | cognitive abilities

Article:

Humor plays an important role in everyday life, from interacting with strangers to attracting mates (Bressler & Balshine, 2006; Earleywine, 2010; Tornquist & Chiappe, 2015). Some people, however, come up with funny and witty ideas much more easily than others. Humor production ability—the ability to generate funny ideas—varies substantially between people, but the sources of individual differences in humor production remain obscure, given the relatively few studies on the cognitive psychology of humor.

In the present research, we examine the role of cognitive abilities in humor production, a topic with a long past (e.g., Feingold & Mazzella, 1991; Galloway, 1994) that has recently attracted more attention (Greengross & Miller, 2011; Kellner & Benedek, 2016). To date, past work has primarily focused on only one or two cognitive abilities, usually vocabulary knowledge and fluid reasoning, as well as on only one kind of humor task (i.e., writing captions for cartoons). Using the Cattell-Horn-Carroll (CHC) model as a framework, we examined a broader range of specific abilities as well as the contribution of general intelligence, estimated via both higher order models and bifactor models. Taken together, the findings clarify the roles of specific and general factors of intelligence and suggest a substantial role for intelligence in humor production.

Funny Ideas

Humor production ability is measured with open-ended tasks (Earleywine, 2010). Participants receive a visual or verbal prompt that sets up an opportunity for humor, they generate a response, and a group of judges then subjectively rates the responses for funniness. By far, the most common humor production task involves asking participants to write captions for single-panel cartoons—virtually every study has used some form of this task (for a review, see Nusbaum & Silvia, in press). Recent years, however, have seen the development of many new tasks, such as asking people to write funny fictional resumes (Howrigan & MacDonald, 2008), sarcastic responses to hypothetical questions (Howrigan & MacDonald, 2008), witty endings to social scenarios (Nusbaum, Silvia, & Beaty, in press), and funny definitions for random noun-noun combinations (e.g., definitions for *yoga bank*, *cereal bus*, or *balloon bench*; Nusbaum et al., in press).

Researchers have correlated scores on humor tasks with a wide range of constructs, from personality traits to demographic factors (Nusbaum & Silvia, in press), but recently they have become interested in how cognitive abilities affect how people generate funny ideas. Models of humor (Attardo, 1994; Raskin, 1985) suggest several reasons why intelligence should be important to variability in humor ability. First, verbal humor draws upon crystallized knowledge of the world as expressed through language. Witty material harnesses nuances in words (Aarons, 2012), such as quirky synonyms (e.g., instead of *fighting*, two people might be *scuffling*, *brawling*, *rasslin'*, or *engaged in a bout of fisticuffs*), word phonology (*Q: What do you call a cross between an elephant and a rhinoceros? A: Hell-if-I-know*), and polysemy (e.g., *outside* in Groucho Marx's quip *Outside of a dog, books are a man's best friend; inside of a dog, it's too dark to read*).

Second, creating humor often requires accessing and manipulating conceptual material that is distant or incompatible, from simple one-liner jokes beloved by little kids (e.g., *Q: What's brown and sticky? A: A stick*) to jokes that set up and contrast competing situation models (e.g., *My grandfather died peacefully in his sleep, but the kids on his bus were freaking out*) to rich and elaborate metaphors (e.g., Barnett Cocks's view that "A committee is a cul-de-sac down which ideas are lured and then quietly strangled"). Theories of humor point out that even simple jokes require accessing, maintaining, and integrating incompatible scripts, frames, or mental workspaces (Attardo, 1994; Goatly, 2012).

As a result, one would expect several factors of intelligence to be important for producing humor. Viewed within a CHC framework (Carroll, 1993; McGrew, 2005, 2009), the two factors that have attracted the most attention are crystallized intelligence (Gc) and fluid intelligence (Gf). Gc's relevance to verbal humor production seems obvious, and many studies show at least medium-sized effects for Gc. Measures of vocabulary knowledge, for example, correlate with the rated funniness of cartoon captions ($r = .38$ in Greengross & Miller, 2011; $r = .37$ in Kellner &

Benedek, 2016), and professional comedians have significantly higher vocabulary scores than university students (Greengross, Martin, & Miller, 2012). Likewise, given the executive control aspects of humor (e.g., maintaining competing representations), one would expect a role for Gf. Two studies found that scores on the Ravens Advanced Progressive Matrices predicted the funniness of cartoon captions (r = .25; Greengross & Miller, 2011) and a composite humor score derived from several tasks (r = .29; Howrigan & MacDonald, 2008), although another study found a smaller effect size using tasks from the Cattell Culture Fair tests (e.g., Kellner & Benedek, 2016; r = .13).

Given the evidence thus far, a CHC approach highlights two open questions. First, the role of *g* in humor production remains unclear. Two studies have estimated the effect of *g*, either by modeling *g* as a higher order factor indicated by Ravens and vocabulary tasks (Greengross & Miller, 2011) or by using a global WISC–R score (Masten, 1986). Both studies found large effects of *g* on humor production—r = .50 (Masten, 1986) and latent *r*s = .67 and .51 for men and women, respectively (Greengross & Miller, 2011)—but the relative contributions of *g* and the lower-order Gf and Gc factors are unknown. Bifactor models (Little, 2013; Reise, 2012) can estimate both specific and general factors, and they are commonly used to separate the contributions of lower-order abilities and *g* (e.g., Gustafsson, 2001; Kvist & Gustafsson, 2008; Silvia, Thomas, Nusbaum, Beaty, & Hodges, 2016).

Second, a CHC approach would suggest that broad retrieval ability (Gr) is probably at least as important as Gf and Gc in humor production ability. In other domains of verbal creativity, verbal fluency tasks consistently emerge as important predictors (Avitia & Kaufman, 2014). For divergent thinking, the higher order Gr factor is an important predictor of the rated creativity of unusual uses (Benedek, Könen, & Neubauer, 2012; Silvia, Beaty, & Nusbaum, 2013). In a CHC study of how people generate creative metaphors (Beaty & Silvia, 2013), Gr predicted the rated creativity of metaphors (β = .52) beyond the effects of Gf (β = .45) and Gc (β = .24). Gr has yet to be examined in humor research, but it captures processes that are likely important. Much like divergent thinking and metaphor, humor involves constructing ad hoc categories and searching for material that meets constraints (e.g., synonyms for *fighting*). The ability to generate retrieval cues and strategies, to create and identify semantic categories, and to switch between strategies and categories despite interference is central to Gr (Rosen & Engle, 1997; Troyer, Moscovitch, & Winocur, 1997; Unsworth, Spillers, & Brewer, 2011).

The Present Research

Using a CHC approach, the present study evaluated how an expanded range of cognitive abilities predicts humor ability. As in past work, we assessed Gf and Gc, but we included Gr to evaluate whether it additionally predicts humor production ability. Furthermore, we expanded on past work by using a much larger number of tasks that would afford bifactor modeling of both the specific factors and *g*, and the effects of *g* were estimated using both higher order and bifactor models. Finally, a broader set of humor tasks, many of them newly developed (Nusbaum et al., in press), was included.

Method

Participants

Our sample was 270 adults enrolled in psychology courses at the University of North Carolina at Greensboro (UNCG). They were primarily young (*M* = 19.08 years, *SD* = 3.14, range = 18 to 48), and everyone indicated speaking English as a native language. The sample had an unusually high proportion of women (86%), consistent with our university's history as a former women's college. Because the sample had relatively few men, gender differences were not evaluated statistically.

Measures

Humor ability. To assess humor production ability, participants completed three different humor tasks. All three tasks have been used in our recent work (Nusbaum et al., in press). Participants were told that the study was interested in humor and how people come up with funny ideas. Just as creativity research instructs people to "be creative" (Nusbaum, Silvia, & Beaty, 2014), humor research instructs people to "be funny." Specifically, for all tasks the participants were told that they should "write something funny" and that what they write "can be weird, silly, gross, bizarre, ironic, dirty-minded, or whatever, so long as it's funny."

The *cartoon captions task* asked participants to write a funny caption for three single-panel cartoons taken from the *New Yorker*. Writing captions for cartoons is by far the most common humor production task (for reviews, see Nusbaum, 2015; Nusbaum & Silvia, in press), and most studies use only cartoon captions to assess humor. The cartoons depicted an astronaut on the moon speaking into a cell phone; a king reclined on a couch speaking to a bearded psychotherapist; and two office workers, one holding a smoking gun, talking next to a dead body.

The *joke stems task* provided participants with a humorous set-up that they were asked to finish with something funny. The set-ups were quirky interpersonal situations that are fertile for humor. They resemble the "How _____ was it?" genre of jokes, in which a comedian baits the audience (e.g., "My friend's singing was terrible"), the audience sets the comedian up ("How terrible was it?"), and the comedian delivers a punchline (e.g., "Her singing was so terrible, my cat threw a shoe at her"). For example, one of scenarios read, "Imagine that your friend invites you over and cooks dinner—and the food is totally horrible and disgusting. Later, when describing it to someone else, you say, 'Wow, that food was so bad . . .'" People were told to complete the phrase "'Wow, that food was so bad . . .'" with something potentially funny (e.g., *a starving child wouldn't eat it*, *it was like chewing on sweaty feet, my vagina hurt*). The other two scenarios involved describing their most boring college class to a friend and describing what it was like listening to a friend's terrible singing. People could complete the joke stem with any response so long as the participant thought it was funny.

Finally, the *definitions task* asked people to write funny definitions for odd concepts. Inspired by research on the creative affordances of conceptual combinations (Benczes, 2006; Wisniewski, 1997), this task presents people with unusual noun-noun combinations that afford funny meanings. People were asked to generate a funny definition for three concepts: *snuggle war*, *cereal bus*, and *yoga bank.* The humor tasks had no time limit.

Three judges (2 men and 1 woman) rated all the responses using a 5-point scale (1 = *Not at all funny*, 5 = *Extremely funny*). The judges made their ratings independently, and they were unaware of the participants' responses to the other humor items as well as their responses to any other task or scale. Based on Primi (2014), we used many-facet Rasch models (Eckes, 2011) to estimate each person's humor score for each task type. Because each task type had three items (e.g., three cartoons) and all responses had three raters, the assessment structure is faceted. Just as a Rasch model seeks to estimate a person's trait score that is adjusted in light of the difficulty of the items he or she took, a many-facet Rasch model estimates a trait score (here, humor ability) adjusted for (1) the "difficulty" of a task's items (i.e., it could be easier to come up with something funny for some items), and (2) the "difficulty" of the raters (i.e., some raters are more lenient, and others are more severe).

Using Facets 3.71.4 (Linacre, 2014), we estimated Rasch "fair average" scores, specifying participants, raters, and items as facets. These scores represent a person's humor ability after adjusting for the difficulty of the items and the severity of the raters, and they are on the same rating scale (1 to 5) as the raw scores. Rasch person-reliability estimates were highest for the definitions (.68) and jokes (.63) tasks and lower for the cartoon captions task (.45). Rasch person-reliability estimates represent the true lower-bound of reliability and are thus lower than reliability estimates like Cronbach's alpha (Eckes, 2011; Linacre, 1997).

Intelligence tasks. Fluid intelligence (Gf) was measured by four tasks. The series completion task (13 items, 3 min) from the Cattell Culture Fair tests (Cattell & Cattell, 1961/2008) required people to identify the shape that completed a developing series of shapes. A letter sets task (15 items, 4 min) showed participants five sets of four letters and asked them which set violated a rule followed by the others (Ekstrom, French, Harman, & Dermen, 1976). A number series task (15 items, 5 min) required people to discern a pattern in a series of digits and select the number that would come next (Thurstone, 1938). Finally, a paper folding task (10 items, 3 min) presented a square piece of paper that had been folded and punched with a hole, and participants had to indicate what the paper would look like when unfolded (Ekstrom et al., 1976). All of these tests have been used in our recent work with similar samples (e.g., Beaty & Silvia, 2012, 2013; Nusbaum & Silvia, 2011; Silvia & Beaty, 2012).

Crystallized intelligence (Gc) was measured with an 18-item Advanced Vocabulary Test and a 24-item Extended Range Vocabulary Test. People were asked to choose the word that meant the same thing, or nearly the same thing, as a target word (Ekstrom et al., 1976).

Finally, broad retrieval ability (Gr) was measured with five fluency tasks: synonyms for *good* and for *hot* and kinds of *animals*, *occupations*, and *fruit and vegetables*. Participants were asked to generate as many words as they could in one minute. Each task was scored for the number of responses, excluding invalid responses, repetitions, and variations on roots.

Results

Analysis Plan and Model Specification

Table 1 presents descriptive statistics and correlations for all the variables. All models were estimated in Mplus 7.4 with maximum likelihood estimation. All the task variables were standardized prior to analysis. Latent Gf, Gc, and Gr variables were formed using their respective tasks as indicators. The factor variances were fixed to 1, and the loadings for the two Gc indicators were constrained to be equal. Humor ability was modeled as a latent variable with the three Rasch fair-average scores (for the captions, jokes, and definitions tasks) as indicators. The loading for the captions task was fixed to 1. The standardized effects are presented in the *r* metric and can be interpreted using the conventional small (.10), medium (.30), and large (.50) guidelines (Cumming, 2012).

Table 1. Descriptive Statistics

Variable	*M* (Variance)	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Cartoon captions	1.56 (.21)	1													
2. Joke stems	1.58 (.23)	.17	1												
3. Definitions	1.76 (.29)	.25	.37	1											
4. Gf: Paper folding	4.85 (4.00)	.10	.08	.11	1										
5. Gf: Series completion	7.54 (2.51)	.03	.01	.08	.29	1									
6. Gf: Letter sets	7.49 (6.68)	.10	.12	.04	.31	.23	1								
7. Gf: Number series	8.05 (7.27)	.04	.06	.13	.37	.27	.48	1							
8. Gc: Advanced vocabulary	7.31 (5.59)	.06	.11	.16	.18	.04	.22	.21	1						
9. Gc: Extended vocabulary	9.47 (9.37)	.34	.13	.24	.31	.04	.24	.34	.35	1					
10. Gr: Good	7.18 (8.11)	.08	.05	.07	.16	.12	.00	.09	−.03	.09	1				
11. Gr: Hot	6.63 (10.53)	.13	.02	.16	.07	.05	.08	.12	.04	.12	.41	1			
12. Gr: Animals	17.80 (16.94)	.17	.15	.26	.17	.06	.19	.20	.13	.28	.34	.34	1		
13. Gr: Jobs	12.10 (13.48)	.15	.05	.23	.14	.12	.01	.14	.04	.18	.27	.32	.51	1	
14. Gr: Fruit and vegetables	14.57 (11.19)	.16	.12	.16	.18	.08	.25	.20	.14	.26	.24	.37	.64	.47	1

Note. n = 270. Gf = fluid intelligence; Gc = crystallized intelligence; Gr = broad retrieval ability.

Relationships Between Humor Ability and CHC Abilities

How did humor production ability correlate with intelligence? Our first model examined the correlations between humor ability and Gf, Gc, and Gr. A confirmatory factor analysis fit well: $\chi^2(72\ df) = 112.768$, $p = .0015$; CFI = .937; RMSEA = .046 [90% CI: .029, .062]; SRMR = .050. Figure 1 depicts the model, and Table 2 displays the factor correlations.

Table 2. Correlations Between Latent Cognitive Abilities and Humor Production Ability

Variable	Humor production	Gf	Gc	Gr
Humor production	1			
Gf	.22 [.04, .39]	1		
Gc	.49 [.29, .70]	.62 [.45, .79]	1	
Gr	.38 [.22, .54]	.35 [.20, .50]	.40 [.22, .57]	1

Note. n = 270. Gf = fluid intelligence; Gc = crystallized intelligence; Gr = broad retrieval ability. The coefficients are correlations between the latent variables and their 95% confidence intervals.

Consistent with past research, Gc had the highest correlation with humor ability ($r = .49$ [.29, .70], $p < .001$), and Gf's effect size was more modest ($r = .22$ [.04, .39], $p = .016$). As we expected, Gr had a notable relationship with humor production ability, between medium and large in size ($r = .38$ [.22, .54], $p < .001$).

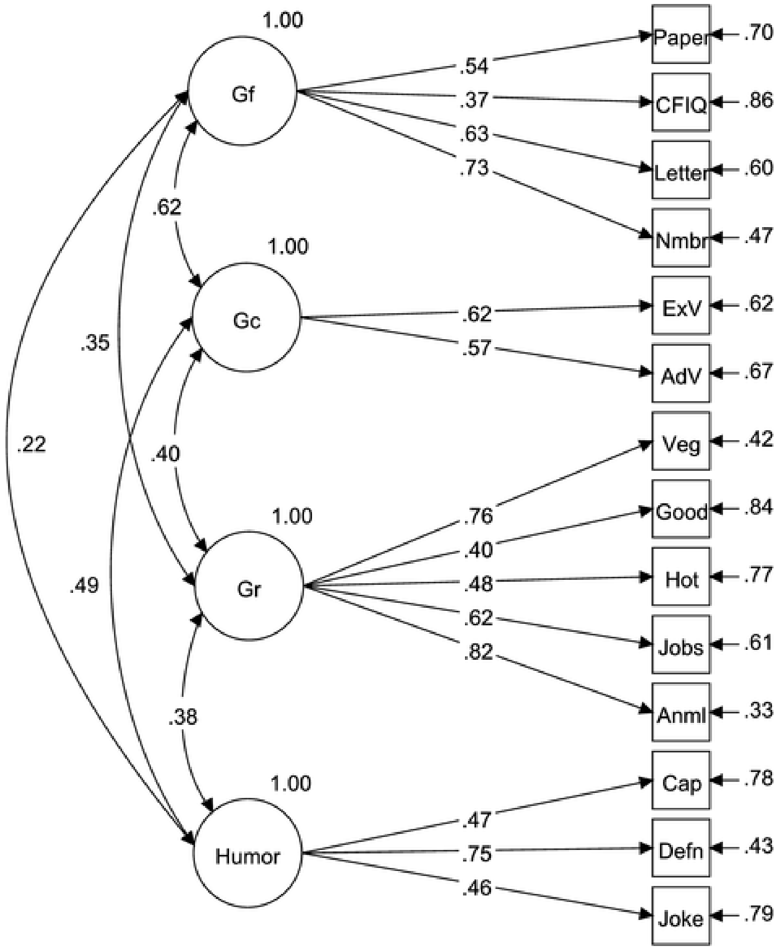

Figure 1. A confirmatory factor analysis of humor production ability and fluid reasoning (Gf), vocabulary knowledge (Gc), and broad retrieval ability (Gr). n = 270. Standardized effects are displayed.

Humor Ability and General Intelligence

All three cognitive abilities correlated with humor production ability and correlated substantially with each other. We thus examined the effect of general intelligence on humor production ability.

Higher order *g*. Our first model estimated *g* as a higher order model, in which Gf, Gc, and Gr served as indicators for *g*, and *g* in turn predicted humor production. Figure 2 depicts this model, which fit well: $\chi^2(74\ df) = 119.916$, $p = .0006$; CFI = .929; RMSEA = .048 [90% CI: .032, .063]; SRMR = .055. In this model, *g* had a large effect on humor ability, $\beta = .51$ [.32, .70], $p < .001$. Notably, this effect size resembles the effect of *g* on humor ability in past studies that used higher order models or composite scores (*r*s between .50 and .67: Greengross & Miller, 2011; Masten, 1986).

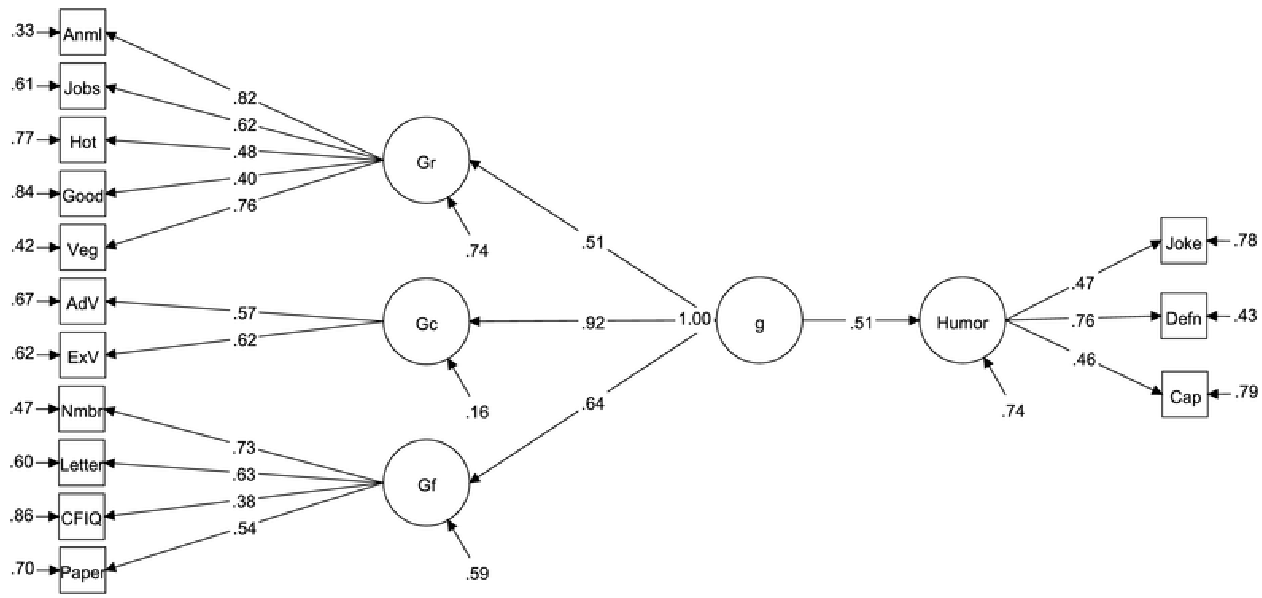

Figure 2. A model of the higher order intelligence factor and humor ability. n = 270. Standardized effects are displayed.

Bifactor *g*. Our second approach to *g* and humor ability used a bifactor model. Unlike the higher order model, a bifactor approach can estimate the effect of the global *g* factor alongside the specific effects of Gf, Gc, and Gr. In a bifactor model, the observed indicators (e.g., the various CHC tasks) are predicted by both a specific factor (e.g., Gf) and a general factor (e.g., *g*). The specific factors thus represent variance in the tasks not accounted for by the general factor. In some cases, one or more of the specific factors gets "absorbed" into the general factor because its effects on the indicators are fully accounted for by the general factor. A common example comes from intelligence research: fluid intelligence is often absorbed into *g* in a bifactor model, suggesting that (in those samples and models) there isn't a specific Gf factor distinct from *g*.

Our first bifactor model specified a higher order *g* factor and specific Gf, Gc, and Gr factors. Signs that a specific factor has been slurped into the higher order one include low or nonsignificant factor loadings for the specific factor or improper estimates (e.g., negative variances or standardized estimates greater than 1) associated with the specific factor. Gc was absorbed into *g* in our model, yielding the final bifactor solution found in Figure 3. This model converged to a proper solution and fit well: $\chi^2(35\ df) = 55.098$, $p = .0166$; CFI = .962; RMSEA = .046 [90% CI: .020, .068]; SRMR = .043.

How did *g* and the specific abilities predict humor production ability? We added humor ability as an outcome to the bifactor model shown in Figure 3: *g*, Gf, and Gr were predictors. The model converged and fit well: $\chi^2(65\ df) = 94.860$, $p = .0092$; CFI = .954; RMSEA = .041 [90% CI: .021, .058]; SRMR = .044. Figure 4 displays the coefficients. Consistent with past research (Greengross & Miller, 2011; Masten, 1986), general intelligence had a large relationship with humor production ability ($\beta = .47$ [.29, .66], $p < .001$). When *g*'s effect was modeled, Gr continued to have a significant specific effect that was between small and medium in size ($\beta = .20$ [.02, .38], $p = .028$). Gf, however, did not; its specific effect on humor ability was small and not significant ($\beta = -.09$ [-.30, .12], $p = .398$).

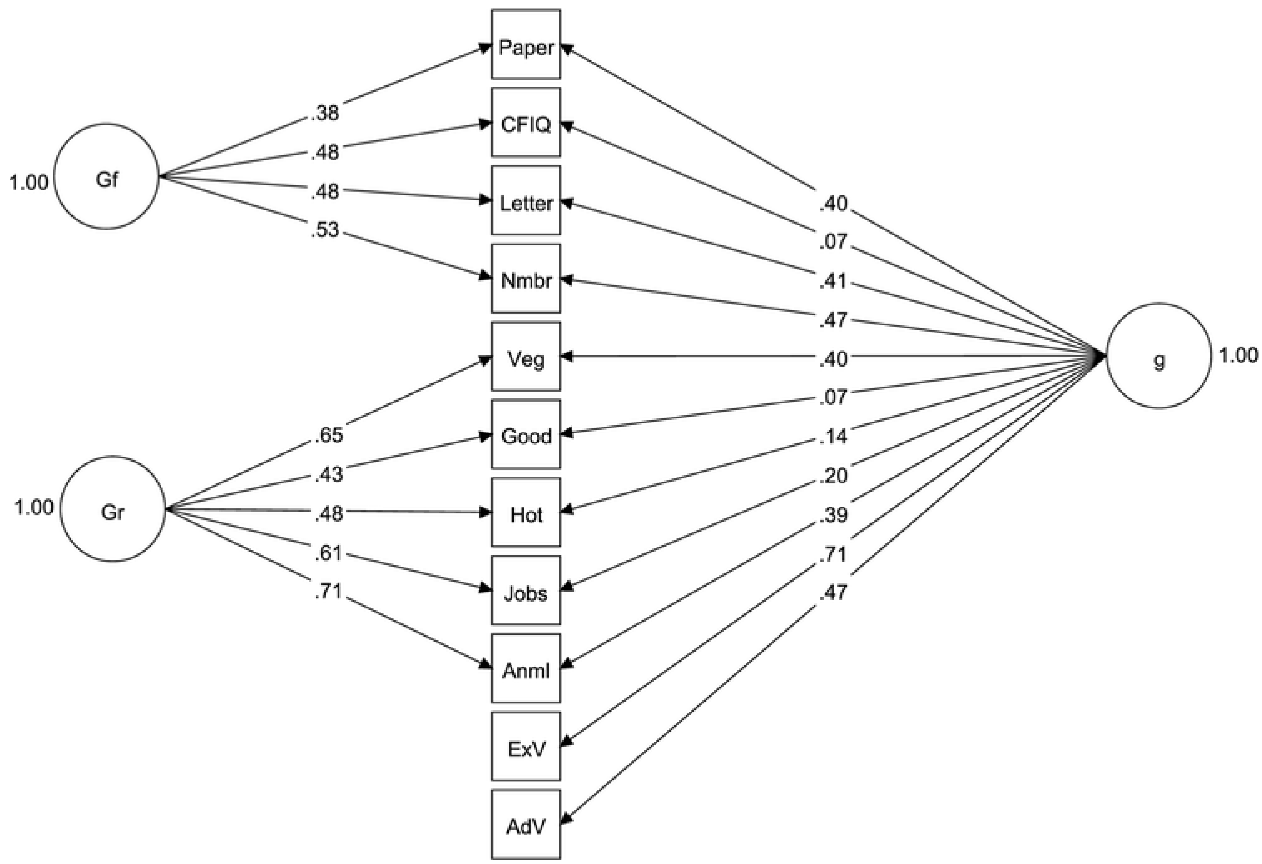

Figure 3. A bifactor model of intelligence. n = 270. Standardized effects are displayed. For clarity, the indicators' residual variances are omitted from the figure.

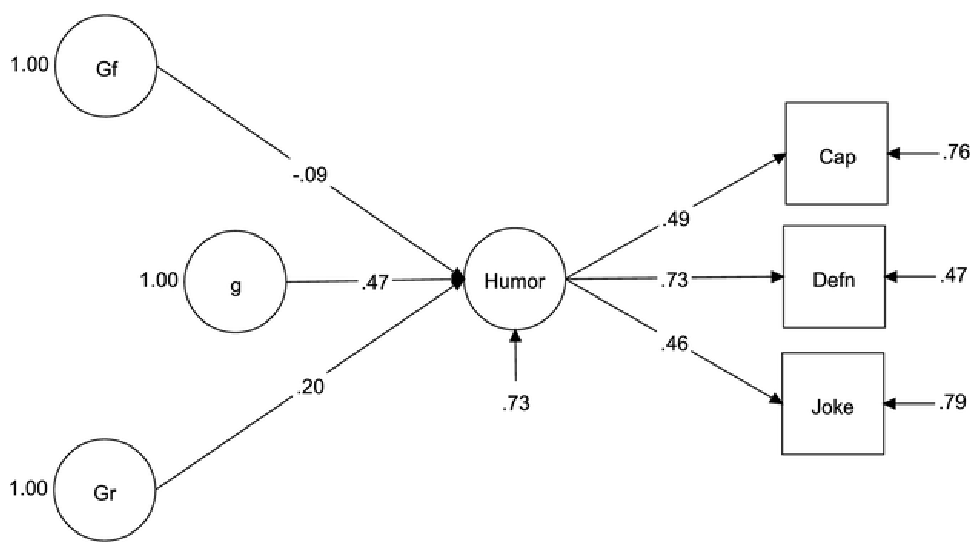

Figure 4. Effects of the bifactor model of intelligence on humor production ability. n = 270. Standardized effects are displayed. For clarity, the indicators in the bifactor model (displayed in Figure 3) are omitted from this figure.

The results of the bifactor model thus clarify the roles of the specific factors in humor ability. First, *g* itself had a large effect size (β = .47). Gc was absorbed into *g* in the bifactor model, reflecting the very strong effect of *g* on the vocabulary tasks in this sample. As a result, there are no effects uniquely attributable to crystallized intelligence in the bifactor model. Second, when *g* was modeled, the effect of Gr declined: Gr's specific effect (β = .20) is smaller than its simple correlation with humor ability (*r* = .38), but it is nevertheless a notable effect size. This means that the abilities uniquely captured by Gr (and not attributable to the effect of *g*) predict humor ability on their own. And third, the effect of Gf shrank from a notable simple correlation (*r* = .22) to a small and nonsignificant specific effect (β = −.09). As a result, Gf didn't uniquely predict humor ability once the effects of *g* on the Gf tasks were taken into account.

Discussion

In the present research, we explored humor production ability from a CHC perspective. The findings both support the small literature on humor ability and extend it in new directions. First, we found that the pattern of simple correlational relationships replicated past research (see Figure 1). As in past research, both fluid intelligence (Gf) and crystallized intelligence (Gc) correlated with humor production ability (Howrigan & MacDonald, 2008; Greengross & Miller, 2011), and Gc had a somewhat larger effect size than Gf (Greengross & Miller, 2011; Kellner & Benedek, 2016). Second, the effect size for *g*—estimated as a second-order factor (see Figure 2)—was large and essentially the same as in past studies (Greengross & Miller, 2011; Masten, 1986). It's important to point out that our study used a much broader set of humor tasks than past work did, so the effects of cognitive abilities on humor replicate across different ways of measuring humor and intelligence.

Moving beyond past work, the present study examined the effect of broad retrieval ability (Gr), a CHC factor that has not yet been examined in humor research. Past work on other domains of verbal creativity find large effects of Gr (Beaty & Silvia, 2013; Benedek et al., 2012; Silvia et al., 2013), and models of verbal humor imply an important role for selective and strategic retrieval processes (Attardo, 1994; Goatly, 2012; Raskin, 1985). As expected, Gr had a notable simple correlation with humor ability (*r* = .38) as well as a unique (but smaller) effect in the bifactor model (β = .20). These effects highlight the value of exploring cognitive abilities beyond Gf and Gc, which are the only CHC factors studied thus far.

Finally, the present study examined the *g* factor more closely by examining both higher order and bifactor models. A higher order model (see Figure 2) found a large effect of *g* (β = .51), consistent with past work. A bifactor model (see Figure 4) found a similarly large effect (β = .47). The bifactor model suggested a more complex picture of cognitive abilities and humor production ability. Gf had a small, nonsignificant specific effect in the bifactor model. This suggests that Gf's simple correlation with humor ability was almost wholly due to its overlap with *g*. Stated differently, the variance in the four Gf tasks that predicts humor ability is the variance due to *g*, not the variance unique to Gf. Gf consistently has a weaker effect than Gc on humor ability in past research (Greengross & Miller, 2011; Kellner & Benedek, 2016), and our bifactor analysis suggests that it doesn't uniquely predict humor above and beyond *g*. As for Gc, no specific Gc factor was identified. The effect of *g* on the Gc tasks was so large that no unique

Gc factor emerged, so it was "absorbed" into *g*. This is surely one reason why the effect of *g* was so large in the bifactor model.

Collectively, the findings illustrate the influential role of intelligence in the ability to come up with funny ideas. The CHC factors, taken together, had a substantial effect on humor production, suggesting that intelligence and humor are closely linked. Moreover, the effects were not restricted solely to crystallized intelligence, an obvious candidate for verbal humor, but were also reflected both in the general *g* factor and in the specific Gr factor. The CHC model thus indicates a range of general and specific roles for cognitive abilities in humor, and it offers a fruitful framework for organizing the growing literature on cognitive abilities and humor, which has been scattered to date (see Galloway, 1994).

The important role of intelligence in humor informs and expands the renewed interest in intelligence and creativity (Silvia, 2015). Despite the longstanding view that intelligence and creativity represent different strengths (Kim, 2005), recent work has revealed a central role for cognitive abilities—particularly abilities related to executive and strategic aspects of thought (Beaty, Benedek, Silvia, & Schacter, 2016)—in verbal creativity (Benedek, Jauk, Sommer, Arendasy, & Neubauer, 2014; Nusbaum & Silvia, 2011). Most of this research has examined divergent thinking tasks (e.g., Benedek et al., 2012; Jauk, Benedek, Dunst, & Neubauer, 2013; Lee & Therriault, 2013; Silvia et al., 2013); a smaller group of studies has explored metaphor production (Beaty & Silvia, 2013; Benedek et al., 2014; Primi, 2014; Silvia & Beaty, 2012).

A CHC approach to different forms of verbal creativity can highlight what these outcomes share and how they might differ. Not many studies have included a broad set of CHC factors, but so far it appears that Gc is probably more important than Gf for humor (Greengross & Miller, 2011; Kellner & Benedek, 2016), Gf might be more important than Gc for divergent thinking and metaphor tasks (Beaty & Silvia, 2013), and Gr seems important to all of them (Beaty & Silvia, 2013; Silvia et al., 2013). The literature is small so far, but consistently evaluating a large set of cognitive abilities in future research would lend insight into the underlying mechanisms that these different expressions of verbal creativity do and do not share.

Acknowledgement: The development of this research was enabled by Grant RFP-15-12 from the Imagination Institute (www.imagination-institute.org), funded by the John Templeton Foundation. The opinions expressed in this publication are those of the authors and do not necessarily reflect the view of the Imagination Institute or the John Templeton Foundation.

References

Aarons, D. (2012). *Jokes and the linguistic mind*. New York, NY: Routledge.

Attardo, S. (1994). *Linguistic theories of humor*. Berlin, Germany: Mouton de Gruyter.

Avitia, M. J., & Kaufman, J. C. (2014). Beyond *g* and *c*: The relationship of rated creativity to long-term storage and retrieval (*Glr*). *Psychology of Aesthetics, Creativity, and the Arts*, *8*, 293–302. 10.1037/a0036772

Beaty, R. E., Benedek, M., Silvia, P. J., & Schacter, D. L. (2016). Creative cognition and brain network dynamics. *Trends in Cognitive Sciences*, *20*, 87–95. 10.1016/j.tics.2015.10.004

Beaty, R. E., & Silvia, P. J. (2012). Why do ideas get more creative across time? An executive interpretation of the serial order effect in divergent thinking tasks. *Psychology of Aesthetics, Creativity, and the Arts*, *6*, 309–319. 10.1037/a0029171

Beaty, R. E., & Silvia, P. J. (2013). Metaphorically speaking: Cognitive abilities and the production of figurative language. *Memory & Cognition*, *41*, 255–267. 10.3758/s13421-012-0258-5

Benczes, R. (2006). *Creative compounding in English: The semantics of metaphorical and metonymical noun-noun combinations*. Amsterdam, the Netherlands: John Benjamins. 10.1075/hcp.19

Benedek, M., Beaty, R., Jauk, E., Koschutnig, K., Fink, A., Silvia, P. J., . . .Neubauer, A. C. (2014). Creating metaphors: The neural basis of figurative language production. *NeuroImage*, *90*, 99–106. 10.1016/j.neuroimage.2013.12.046

Benedek, M., Jauk, E., Sommer, M., Arendasy, M., & Neubauer, A. C. (2014). Intelligence, creativity, and cognitive control: The common and differential involvement of executive functions in intelligence and creativity. *Intelligence*, *46*, 73–83. 10.1016/j.intell.2014.05.007

Benedek, M., Könen, T., & Neubauer, A. C. (2012). Associative abilities underlying creativity. *Psychology of Aesthetics, Creativity, and the Arts*, *6*, 273–281. 10.1037/a0027059

Bressler, E. R., & Balshine, S. (2006). The influence of humor on desirability. *Evolution and Human Behavior*, *27*, 29–39. 10.1016/j.evolhumbehav.2005.06.002

Carroll, J. B. (1993). *Human cognitive abilities: A survey of factor-analytic studies*. New York, NY: Cambridge University Press. 10.1017/CBO9780511571312

Cattell, R. B., & Cattell, A. K. S. (2008). *Measuring intelligence with the Culture Fair Tests*. Oxford, United Kingdom: Hogrefe. (Original work published 1961)

Cumming, G. (2012). *Understanding the new statistics: Effect sizes, confidence intervals, and meta-analysis*. New York, NY: Routledge.

Earleywine, M. (2010). *Humor 101*. New York, NY: Springer.

Eckes, T. (2011). *Introduction to many-facet Rasch measurement: Analyzing and evaluating rater-mediated assessments*. Frankfurt am Main, Germany: Peter Lang. 10.3726/978-3-653-04844-5

Ekstrom, R. B., French, J. W., Harman, H. H., & Dermen, D. (1976). *Manual for kit of Factor-Referenced Cognitive Tests*. Princeton, NJ: Educational Testing Service.

Feingold, A., & Mazzella, R. (1991). Psychometric intelligence and verbal humor ability. *Personality and Individual Differences*, *12*, 427–435. 10.1016/0191-8869(91)90060-O

Galloway, G. (1994). Psychological studies of the relationship of sense of humor to creativity and intelligence: A review. *European Journal for High Ability*, *5*, 133–144. 10.1080/0937445940050203

Goatly, A. (2012). *Meaning and humor*. Cambridge, United Kingdom: Cambridge University Press. 10.1017/CBO9780511791536

Greengross, G., Martin, R. A., & Miller, G. (2012). Personality traits, intelligence, humor styles, and humor production ability of professional stand-up comedians compared to college students. *Psychology of Aesthetics, Creativity, and the Arts*, *6*, 74–82. 10.1037/a0025774

Greengross, G., & Miller, G. (2011). Humor ability reveals intelligence, predicts mating success, and is higher in males. *Intelligence*, *39*, 188–192. 10.1016/j.intell.2011.03.006

Gustafsson, J. E. (2001). On the hierarchical structure of ability and personality. In J. M.Collis & S.Messick (Eds.), *Intelligence and personality: Bridging the gap in theory and measurement* (pp. 25–42). London, United Kingdom: Erlbaum.

Howrigan, D. P., & MacDonald, K. B. (2008). Humor as a mental fitness indicator. *Evolutionary Psychology*, *6*, 652–666. 10.1177/147470490800600411

Jauk, E., Benedek, M., Dunst, B., & Neubauer, A. C. (2013). The relationship between intelligence and creativity: New support for the threshold hypothesis by means of empirical breakpoint detection. *Intelligence*, *41*, 212–221. 10.1016/j.intell.2013.03.003

Kellner, R., & Benedek, M. (2016). The role of creative potential and intelligence for humor production. *Psychology of Aesthetics, Creativity, and the Arts*. Advance online publication. 10.1037/aca0000065

Kim, K. H. (2005). Can only intelligent people be creative? A meta-analysis. *Journal of Secondary Gifted Education*, *16*, 57–66.

Kvist, A. V., & Gustafsson, J. E. (2008). The relation between fluid intelligence and the general factor as a function of cultural background: A test of Cattell's Investment theory. *Intelligence*, *36*, 422–436. 10.1016/j.intell.2007.08.004

Lee, C. S., & Therriault, D. J. (2013). The cognitive underpinnings of creative thought: A latent variable analysis exploring the roles of intelligence and working memory in three creative thinking processes. *Intelligence*, *41*, 306–320. 10.1016/j.intell.2013.04.008

Linacre, J. M. (1997). KR-20/Cronbach Alpha or Rasch person reliability: Which tells the "truth"?*Rasch Measurement Transactions*, *11*, 580–581.

Linacre, J. M. (2014). *FACETS 3.71.4* [Computer software]. Chicago, IL: Winsteps.

Little, T. D. (2013). *Longitudinal structural equation modeling*. New York, NY: Guilford Press.

Masten, A. S. (1986). Humor and competence in school-aged children. *Child Development*, *57*, 461–473. 10.2307/1130601

McGrew, K. S. (2005). The Cattell-Horn-Carroll theory of cognitive abilities. In D. P.Flanagan & P. L.Harrison (Eds.), *Contemporary intellectual assessment: Theories, tests, and issues* (2nd ed., pp. 136–181). New York, NY: Guilford Press.

McGrew, K. S. (2009). CHC theory and the human cognitive abilities project: Standing on the shoulders of the giants of psychometric intelligence research. *Intelligence*, *37*, 1–10. 10.1016/j.intell.2008.08.004

Nusbaum, E. C. (2015). *A meta-analysis of individual differences in humor production and personality*. Unpublished doctoral dissertation, University of North Carolina at Greensboro.

Nusbaum, E. C., & Silvia, P. J. (2011). Are intelligence and creativity really so different? Fluid intelligence, executive processes, and strategy use in divergent thinking. *Intelligence*, *39*, 36–45. 10.1016/j.intell.2010.11.002

Nusbaum, E. C., & Silvia, P. J. (in press). What are funny people like? Exploring the crossroads of humor ability and openness to experience. In G. J.Feist, R.Reiter- Palmon, & J. C.Kaufman (Eds.), *Cambridge handbook of creativity and personality research*. New York, NY: Cambridge University Press.

Nusbaum, E. C., Silvia, P. J., & Beaty, R. E. (in press). Ha ha? Assessing individual differences in humor production ability. *Psychology of Aesthetics, Creativity, and the Arts*.

Nusbaum, E. C., Silvia, P. J., & Beaty, R. E. (2014). Ready, set, create: What instructing people to "be creative" reveals about the meaning and mechanisms of divergent thinking. *Psychology of Aesthetics, Creativity, and the Arts*, *8*, 423–432. 10.1037/a0036549

Primi, R. (2014). Divergent productions of metaphors: Combining many-facet Rasch measurement and cognitive psychology in the assessment of creativity. *Psychology of Aesthetics, Creativity, and the Arts*, *8*, 461–474. 10.1037/a0038055

Raskin, V. (1985). *Semantic mechanisms of humor*. Dordrecht, Holland, the Netherlands: D. Reidel.

Reise, S. P. (2012). The rediscovery of bifactor measurement models. *Multivariate Behavioral Research*, *47*, 667–696. 10.1080/00273171.2012.715555

Rosen, V. M., & Engle, R. W. (1997). The role of working memory capacity in retrieval. *Journal of Experimental Psychology: General*, *126*, 211–227. 10.1037/0096-3445.126.3.211

Silvia, P. J. (2015). Intelligence and creativity are pretty similar after all. *Educational Psychology Review*, *27*, 599–606. 10.1007/s10648-015-9299-1

Silvia, P. J., & Beaty, R. E. (2012). Making creative metaphors: The importance of fluid intelligence for creative thought. *Intelligence*, *40*, 343–351. 10.1016/j.intell.2012.02.005

Silvia, P. J., Beaty, R. E., & Nusbaum, E. C. (2013). Verbal fluency and creativity: General and specific contributions of broad retrieval ability (Gr) factors to divergent thinking. *Intelligence*, *41*, 328–340. 10.1016/j.intell.2013.05.004

Silvia, P. J., Thomas, K. S., Nusbaum, E. C., Beaty, R. E., & Hodges, D. A. (2016). How does music training predict cognitive abilities? A bifactor approach to musical expertise and intelligence. *Psychology of Aesthetics, Creativity, and the Arts*, *10*, 184–190. 10.1037/aca0000058

Thurstone, L. L. (1938). *Primary mental abilities*. Chicago, IL: University of Chicago Press.

Tornquist, M., & Chiappe, D. (2015). Effects of humor production, humor receptivity, and physical attractiveness on partner desirability. *Evolutionary Psychology*, *13*, 1–13. 10.1177/1474704915608744

Troyer, A. K., Moscovitch, M., & Winocur, G. (1997). Clustering and switching as two components of verbal fluency: Evidence from younger and older healthy adults. *Neuropsychology*, *11*, 138–146. 10.1037/0894-4105.11.1.138

Unsworth, N., Spillers, G. J., & Brewer, G. A. (2011). Variation in verbal fluency: A latent variable analysis of clustering, switching, and overall performance. *Quarterly Journal of Experimental Psychology: Human Experimental Psychology*, *64*, 447–466. 10.1080/17470218.2010.505292

Wisniewski, E. J. (1997). Conceptual combination: Possibilities and esthetics. In T. B.Ward, S. M.Smith, & J.Vaid (Eds.), *Creative thought: An investigation of conceptual structures and processes* (pp. 51–81). Washington, DC: American Psychological Association. 10.1037/10227-003