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BF_3-Promoted Aromatic Substitution of *N*-Alkyl *α*-Trifluoromethylated Imine: Facile Synthesis of 1-Aryl-2,2,2-trifluoroethylamines

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The aromatic substitution of three representative *N*-alkyl trifluoromethyl imines **1a–c** (R: a, benzyl; b, benzhydryl; c, methyl), obtained from primary alkyl amines and trifluoroacetaldehyde ethyl hemiacetal, was used to investigate the preparation of 1-aryl-2,2,2-trifluoroethylamines. In the presence of $BF_3{\cdot}OEt_2$, the reaction of imine **1** with various aromatic compounds proceeded smoothly at room temperature, giving *N*-alkyl-1-aryl-2,2,2-trifluoroethylamines in moderate-to-high yields. Moreover, successful regioselective removal of *N*-benzyl and *N*-benzhydryl groups was achieved by hydrolysis in hydrochloric acid or by palladium-catalyzed hydrogenolysis.

α-Trifluoromethylated amine is a useful building block in pharmaceutical synthesis because the introduction of fluorine atoms to its *β*-carbon atom often confers special physicochemical and biological properties.[1–3] The development of novel methods for synthesizing *α*-trifluoromethylated amine remains of interest. Recent reports on the preparation of *α*-trifluoromethylated amines mainly involve the (1) a reductive amination of *α*-trifluoromethylated ketones,[4] (2) a 1,3-hydrogen shift of *N*-benzyl perfluroalkylated imine,[5] (3) a nucleophilic addition of Grignard reagents or sulfoxide anion to imine[6] and hydrazones[7] derived from trifluoroacetaldehyde, (4) an ene reaction of *N*-tosyl trifluoromethylated imine,[8] (5) a nucleophilic addition of trimethyl(trifluoromethyl)silane to nitrones,[9] imines,[10] and *N*-tosyl[11] and *N*-(*t*-butylsulfinyl) aldimines,[12] and (6) a reduction of $LiAlH_4$ and a nucleophilic substitution of organolithium with fluoral-derived 1,3-oxazolidines.[13] In addition, trifluoroacetimidoyl halides are very useful reagents for preparing *α*-trifluoromethylated amine and its derivatives.[14]

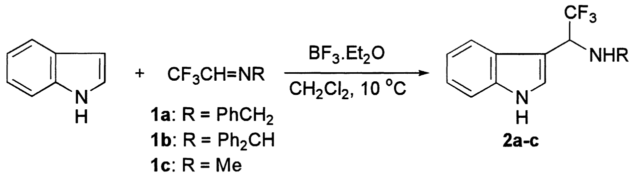
Recently, nucleophilic additions to imines in the presence of catalysts have been widely investigated.[15–19] Reports on the electrophilic aromatic substitution of imines are very few; to our knowledge, there is only the Cu(I)-catalyzed enantioselective substitution of pyrrole, indole, and *N*,*N*-dimethylanilines with the *N*-tosylimino or *N*-ethoxycarbonylimino esters of ethyl glyoxylate.[20,21] Only a few examples of the aromatic substitution of fluorinated imines have been reported.[22] However, these examples have a narrow spectrum of application because of the vigorous reaction conditions and limited aromatic substrates.

Fortunately, our recent work showed that *N*-alkyl *α*-trifluoromethylated imines are reactive enough to undergo a BF_3-promoted substitution reaction with various electron-rich heteroaromatic and aromatic compounds at room temperature, which has been published as a communication.[23] Subsequent experimental results clearly show that the direct substitution reaction is an efficient way to prepare the important *N*-methyl-1-aryl-2,2,2-trifluoroethylamines when *N*-methyl *α*-trifluoromethylated imine **1c** is used as the starting material. Moreover, 1-aryl-2,2,2-trifluoroethylamines are easily obtained by the selective removal of *N*-benzyl and *N*-benzhydryl groups from the generated substitution products. Apparently, our new preparative method has the advantage of simultaneously directly introducing trifluoromethyl and amino function groups into the aromatic compounds. We therefore report on the details for preparing 1-aryl-2,2,2-trifluoroethylamines via the substitution reaction of various hetereoaromatic and aromatic compounds with *N*-alkyl *α*-trifluoromethylated imines **1** and subsequent selective dealkylation.

Results

N-Alkyl imines **1a** and **1b** were prepared by refluxing equivalent amounts of trifluoroacetaldehyde ethyl hemiacetal (TFAE) and the corresponding amine in toluene. The imines were easily obtained by removal of the solvent under reduced pressure, and used without purification. *N*-Methyl imine **1c** was prepared by heating 2,2,2-trifluoro-1-(methylamino)-ethanol[24] in toluene, and was then collected by distillation.

The reaction of imine **1a** with electron-rich indole did not occur in CH_2Cl_2 at room temperature. In the presence of 10 mol% of diethyl ether-boron trifluoride ($BF_3{\cdot}OEt_2$), however, the reaction proceeded smoothly (Scheme 1). Subsequent optimization experiments showed that a high yield of benzyl-[2,2,2-trifluoro-1-(1*H*-indol-3-yl)ethyl]amine **2a** was obtained when 50 mol% of $BF_3{\cdot}OEt_2$ was used (Table 1, Entries 1–4).



Scheme 1.

Table 1. Effect of the Amount of BF_3 on Aromatic Substitution with Imine **1a**[a)]

Entry	Substrate	BF_3/mol%	Conditions	Products (Yield/%)[b)]
1	Indole	10	10 °C, 2 h	**2a** (21)
2	Indole	25	10 °C, 2 h	**2a** (67)
3	Indole	50	10 °C, 2 h	**2a** (95)
4	Indole	100	10 °C, 2 h	**2a** (76)
5	$PhNMe_2$	10	10 °C, 12 h	**8a** (23)
6	$PhNMe_2$	25	10 °C, 12 h	**8a** (70)
7	$PhNMe_2$	50	10 °C, 12 h	**8a** (95)
8	$PhNMe_2$	100	10 °C, 12 h	**8a** (96)

a) Substrate (5.0 mmol) and **1a** (5.0 mmol) in CH_2Cl_2 (10 mL). b) Determined by ^{19}F NMR.

Table 2. Reaction of Various Arenes with Imine **1** in CH_2Cl_2[a)]

Entry	Substrate	Imine	BF_3[b)]	Conditions	Products (Yield/%)[c)]
1	indole	**1a**	50	10 °C, 2 h	**2a** (92)
2	pyrrole	**1a**	50	10 °C, 2 h	**3a** (87)
3	1-Me-pyrrole	**1a**	50	10 °C, 4 h	**4a** (57), **5a** (24)
4	imidazole	**1a**	50	10 °C, 8 h	none
5	furan	**1a**	50	10 °C, 8 h	**6a** (23)
6	thiophene	**1a**	50	10 °C, 8 h	**7a** (18)
7	thiophene	**1a**	100	10 °C, 48 h	**7a** (55)
8	$PhNMe_2$	**1a**	50	10 °C, 8 h	**8a** (91)
9	4-Me-$C_6H_4NMe_2$	**1a**	50	10 °C, 8 h	none
10	PhOH	**1a**	50	10 °C, 8 h	**9a** (19), **10a** (8)
11	PhOH	**1a**	100	10 °C, 48 h	**9a** (54), **10a** (21)
12	2,6-di-Me-phenol	**1a**	100	10 °C, 48 h	**11a** (76)
13	resorcinol	**1a**	100	10 °C, 12 h	**12** (27), **13** (29)
14	indole	**1b**	50	10 °C, 2 h	**2b** (93)
15	pyrrole	**1b**	50	10 °C, 2 h	**3b** (92)
16	1-Me-pyrrole	**1b**	50	10 °C, 4 h	**4b** (64)
17	furan	**1b**	50	10 °C, 8 h	**6b** (33)
18	thiophene	**1b**	100	10 °C, 48 h	**7b** (72)
19	$PhNMe_2$	**1b**	50	10 °C, 8 h	**8b** (80)
20	PhOH	**1b**	100	10 °C, 36 h	**9b** (62), **10b** (23)
21	2,6-di-Me-phenol	**1b**	100	10 °C, 48 h	**11b** (78)
22	2-MeO-phenol	**1b**	100	10 °C, 36 h	**14b** (85)
23	$PhOCH_3$	**1b**	100	10 °C, 36 h	**15b** (8)[d)]
24	1-naphthol	**1b**	100	10 °C, 12 h	**16b** (45), **18** (27)
25	2-naphthol	**1b**	100	10 °C, 12 h	**17b** (80), **19** (11)
26	indole	**1c**	50	10 °C, 2 h	**2c** (89)
27	pyrrole	**1c**	50	10 °C, 3 h	**3c** (86)
28	1-Me-pyrrole	**1c**	50	10 °C, 3 h	**4c** (69), **5c** (17)
29	$PhNMe_2$	**1c**	50	10 °C, 12 h	**8c** (85)
30	PhOH	**1c**	100	10 °C, 48 h	**9c** (50), **10c** (12)[d)]
31	2-MeO-phenol	**1c**	100	10 °C, 36 h	**14c** (78)
32	2-naphthol	**1c**	100	10 °C, 12 h	**17c** (68)

a) Substrate (5.0 mmol) and **1** (5.0 mmol) in CH_2Cl_2 (10 mL). b) Molar ratio of BF_3: substrate (mol%). c) Isolated yields. d) Estimated by ^{19}F NMR, *p*-/*o*- ratio is about 19:1 for entry 23.

This led us to investigate the reactions of **1a** with other heteroaromatic compounds under the same conditions. The results are given in Table 2. With pyrrole, benzyl[2,2,2-trifluoro-1-(1*H*-pyrrol-2-yl)ethyl]amine **3a** (Chart 1) was obtained in high yield (Table 2, Entry 2). With 1-methylpyrrole, both the 2- and 3-substituted products, **4a** and **5a**, were produced (Entry 3). With imidazole, no substitution occurred (Entry 4). Furan also had the same reaction, but yielded complicated products besides **6a** (Entry 5). In the case of thiophene, the low yield of **7a** (Entry 6) was attributed to a lower conversion because no considerable side-products were detected. In fact, the yield of **7a** markedly improved when the reaction was undertaken with a higher molar ratio of $BF_3 \cdot OEt_2$ and for a longer period (Entry 7).

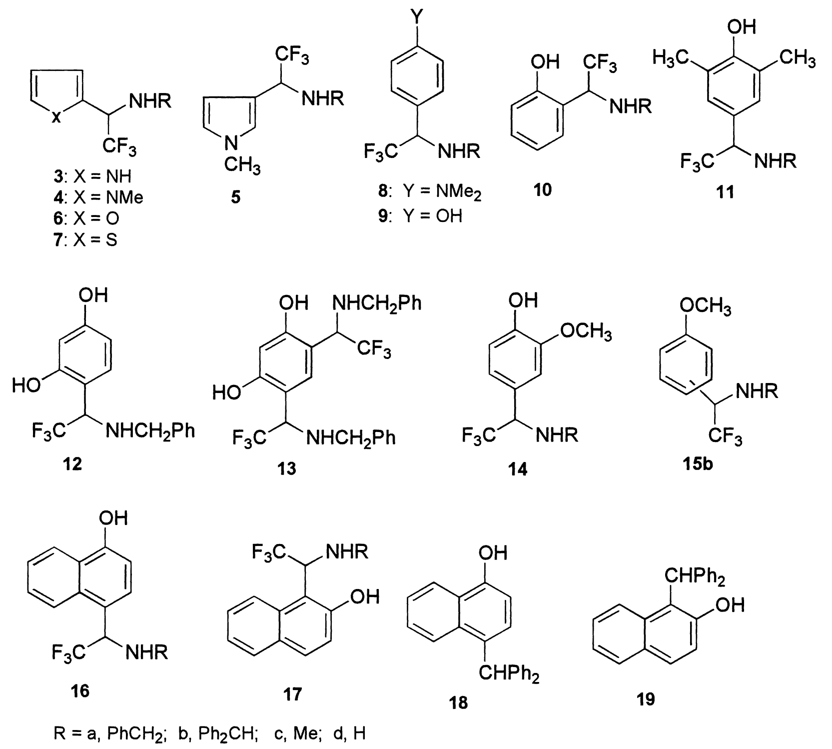


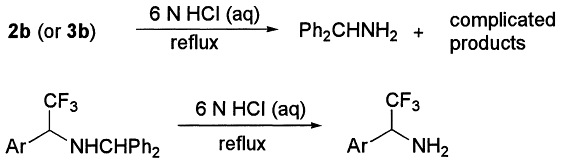
Chart 1.

The BF_3-promoted reaction of **1a** with benzene derivatives was also examined. With *N*,*N*-dimethylaniline, the reaction proceeded smoothly, giving only the *p*-substituted product **8a**. A high yield of **8a** was obtained by the addition of about 50 mol% of $BF_3{\cdot}OEt_2$ (Table 1, Entries 5–8). No *o*-substitution was observed in the reaction with 4,*N*,*N*-trimethylaniline under the same conditions (Table 2, Entry 9). In the case of less reactive acetanilide, only a small amount of substituted product was detected by ^{19}F NMR and MS. With phenol, a 19% yield of the *p*-substituted product **9a** was obtained in the presence of 50 mol% of $BF_3{\cdot}OEt_2$ (Entry 10), but the yield improved markedly under alternative conditions (Entry 11). In addition, some *o*-substituted product, **10a**, was detected. The two isomers were easily separated by silica-gel column chromatography. *p*-Substituted compound **11a** was the only product in the corresponding reaction with 2,6-dimethylphenol (Entry 12). In none of those cases was the formation of a di-substituted product detected. One exception was the reaction of resorcinol with **1a**, in which case the formation of the di-subsituted product **13** was comparable to that of the mono-substituted product **12** (Entry 13). The details about the stereochemistry of **13** are unknown because there are two chiral carbon atoms in its molecular structure.

Using this method, we prepared *N*-benzhydryl-1-aryl-2,2,2-trifluoroethylamines by means of *N*-benzhydryl imine **1b** because the benzhydryl group of these amines is easily removed by hydrolysis in aqueous HCl. Reactions of **1b** with indole, pyrrole, 1-methylpyrrole, furan, thiophene, *N*,*N*-dimethylaniline, phenol, and 2,6-dimethylphenol were proceeded under the conditions described above. A product analysis clearly showed no obvious difference in the product distribution, as compared with that of **1a** (Table 2, Entries 14–21), except for the case of 1-methylpyrrole, in which only 2-substituted product **4b** was obtained (Entry 16). The reactions of **1b** with 2-methoxyphenol, anisole, 1-naphthol, and 2-naphthol were also examined under these conditions. With 2-methoxyphenol, only one mono-substituted product was obtained in high yield (Entry 22). Its structure was assigned to be 4-substituted product **14b** because anisole shows a much lower reactivity than phenol, mainly giving *p*-substituted product **15b** (*p*-/*o*- ratio is about 19:1) in very low yield (Entry 23). 4-Substituted product **16b** and 1-substituted product **17b** were the main products in the respective reactions with 1-naphthol and 2-naphthol (Entries 24–25). In addition, a side-reaction product, **18** or **19**, was obtained.

Due to the considerable importance of *N*-methyl-1-arylethylamines in pharmaceutical research,[25] reactions of *N*-methyl imine **1c** with indole, pyrrole, 1-methylpyrrole, *N*,*N*-dimethylaniline, phenol, 2-methoxyphenol, and 2-naphthol were next investigated under the above conditions. All of the reactions proceeded smoothly, the corresponding *N*-methyl-1-aryl-2,2,2-trifluoroethylamines being formed in good yields (Table 2, Entries 26–32).

The *N*-benzhydryl group was removed from amines **2b–17b** by reflux in 6 M aqueous HCl.[26] A practical hydrolysis was performed by heating a mixture of 1.5 mmol of amine, 5.0 mL of glacial acetic acid, and 5.0 mL of 6 M HCl at 100 °C (Scheme 2). With **2b** and **3b**, benzhydrylamine was the main product, but the expected products, 1-aryl-2,2,2-trifluoroethylamines **2d** and **3d**, were not formed (Table 3, Entries 1-2). The corresponding reaction of **4b** yielded complicated products, possibly due to the generated benzhydryl cation attacking the pyrrole rings (Entry 3). In contrast, a moderate yield of 2,2,2-trifluoro-1-(thiophen-2-yl)ethylamine **7d** was obtained in



Scheme 2.

Table 3. Hydrolysis of Various *N*-Benzhydryl Amines in Aqueous HCl[a)]

Entry	Substrate	Conditions	Products (Yield/%)[b)]
1	**2b**	reflux, 4 h	**2d** (none), Ph_2CHNH_2 (86)
2	**3b**	reflux, 4 h	**3d** (none), Ph_2CHNH_2 (83)
3	**4b**	reflux, 4 h	complicated
4	**7b**	reflux, 36 h	**7d** (52)
5	**8b**	reflux, 6 h	**8d** (81)
6	**9b**	reflux, 36 h	**9d** (61)
7	**10b**	reflux, 36 h	**10d** (71)
8	**11b**	reflux, 12 h	**11d** (72)
9	**14b**	reflux, 12 h	**14d** (90)
10	**15b**	reflux, 8 h	**15d** (81)
11	**17b**	reflux, 8 h	**17d** (79)

a) Substrate (3.0 mmol) in 6 M aqueous HCl (8.0 mL).
b) Isolated yields.

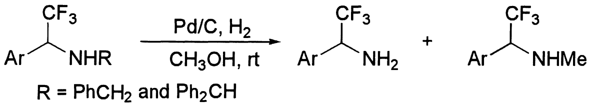
the reaction of **7b** (Entry 4). With **8b–17b**, the corresponding 1-aryl-2,2,2-trifluoroethylamines **8d–17d** were produced in similar good yields (Entries 5–11).

We also investigated the removal of the benzyl or benzhydryl groups by palladium-catalyzed hydrogenolysis from the amines listed in Table 4. Hydrogenolysis in methanol was carried out under a hydrogen atmosphere at room temperature in the presence of Pd/C (Scheme 3). Under these conditions, except for **7a** with a thiophene ring, reactions for all the *N*-benzyl or *N*-benzhydryl amines readily occurred. A product analysis clearly showed the predominant formation of 1-aryl-2,2,2-trifluoroethylamines via the selective removal of the benzyl or benzhydryl groups, indicating that the removal of the 1-aryl-2,2,2-trifluoroethyl group is much more difficult than that of the former groups under these conditions. Besides 1-aryl-2,2,2-trifluoroethylamine, a small amount of the unexpected *N*-methylated product was generated during the reaction. The structure of the *N*-methylated product, carefully identified by spectrometry, was consistent with that of the product prepared from *N*-methyl imine **1c**. All of the products and yields are given in Table 4 (Entries 1–11). The mechanism for the formation of *N*-methylated product remains unclear.

Table 4. Pd-Catalyzed Hydrogenolysis of Various *N*-Alkyl Amines in CH_3OH[a)]

Entry	Substrate	Conditions	Products (Yield/%)[b)]
1	**2a**	rt, 12 h	**2d** (82), **2c** (18)
2	**2b**	rt, 24 h	**2d** (85), **2c** (15)
3	**3a**	rt, 24 h	**3d** (73), **3c** (27)
4	**3b**	rt, 12 h	**3d** (73), **3c** (27)
5	**4a**	rt, 24 h	**4d** (86), **4c** (14)
6	**4b**	rt, 12 h	**4d** (70), **4c** (30)
7	**5a**	rt, 12 h	**5d** (79), **5c** (21)
8	**7a**	rt, 12 h	none
9	**8a**	rt, 24 h	**8d** (59), **8c** (41)
10	**9a**	rt, 12 h	**9d** (75), **9c** (25)
11	**17b**	rt, 24 h	**17d** (67), **17c** (33)

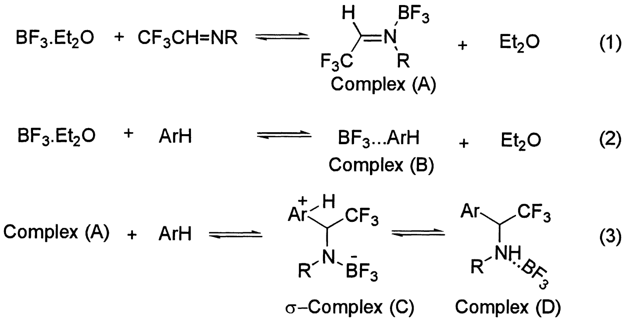
a) Substrate (2.0 mmol), 5% Pd/C (0.42 g) in CH_3OH (10 mL). b) Determined by ^{19}F NMR.



Scheme 3.

Discussion

As introduced above, indole did not react with imine **1a** in the absence of a Lewis acid, but the addition of diethyl ether–boron trifluoride led to a rapid substitution of the indole ring. Moreover, the molar ratio of diethyl ether–boron trifluoride to the substrate had a great influence on the product yields (see Table 1). These experimental results clearly indicate that the Lewis acid $BF_3{\cdot}OEt_2$ markedly promoted aromatic substitution, and its catalytic activity was gradually lowered during the reaction, and almost lost eventually. Based on this observation, we suggest a plausible mechanism for BF_3-promoted aromatic substitution, as shown in Scheme 4. When $BF_3{\cdot}OEt_2$ was mixed with imine **1a** and an aromatic compound, the following coordination equilibria (reactions 1 and 2) would be quickly established to form new complexes (A) and (B). In the case of indole, the formation of complex (A) may be much more important than that of (B) because of the poor coordinating ability of indole. The coordination of imine **1a** with BF_3 would decrease the electron density of its α-carbon atom, hence increasing its reactivity toward indole. A direct attack of complex (A) at the indole ring gave a reactive intermediate σ-complex (C), which easily collapsed into amine complex (D). It is well known that the complex of boron trifluoride with aliphatic amine is very stable and shows low catalytic activity. However, the introduction of a strong electron-withdrawing α-trifluoromethyl group weakens the electron-donating ability of amine **2a**. We therefore consider that though its catalytic activity may be somewhat lower than $BF_3{\cdot}OEt_2$, complex (D) still has the ability to promote the substitution of reactive aromatic compounds with imine **1a**. It is the reason why the use of about 50 mol% of $BF_3{\cdot}OEt_2$ leads to the formation of **2a** in a yield as high as 95%.



Scheme 4.

On the other hand, complex (D), however, is not reactive enough to promote the substitution of imine **1a** with the less-reactive aromatic compounds used. It is clearly shown in Table 2 that in the presence of 50 mol% of $BF_3 \cdot OEt_2$, the reaction of such a reactive aromatic compound as indole or pyrrole with imine **1a** produced a high yield of the substituted product (Entries 1–2), whereas that of a less-reactive aromatic compound, like phenol, gave only a low yield under the same conditions (Entry 10). This means that the reactivity of aromatic compounds also has a striking effect on the reaction and the product distribution. One exception is the reaction of reactive imidazole with **1a**, in which no substitution occurred. In addition, the reaction of furan or thiophene with imine **1a** provided the corresponding substituted product in low yield. Another interesting result is that the reaction with *N*,*N*-dimethylaniline smoothly took place to afford a high yield of *p*-substituted product **8a**, but no substitution occurred with 4,*N*,*N*-trimethylaniline under the above conditions. In contrast, both *p*- and *o*-substituted products **9a** and **10a** were obtained in the corresponding reaction with phenol. All of the results clearly indicate that the main factors affecting the reactivity of aromatic compounds are the intrinsic electron density, the coordinating ability with boron trifluoride, and the steric hindrance. With imidazole, the low reactivity should be attributed to the efficient coordination of the ring nitrogen atom with a lone pair of electrons with boron trifluoride, which decreases the electron density of the imidazole ring and the catalytic activity of boron trifluoride simultaneously. With 4,*N*,*N*-trimethylaniline, no substitution may be mainly due to the high steric hindrance of its ortho position. The effect of a steric hindrance on product distribution is easily understood by comparing the reaction of pyrrole (Entry 2) with that of 1-methylpyrrole (Entry 3). The reaction of pyrrole with imine **1a** afforded only 2-substituted product **3a**, whereas that of 1-methylpyrrole gave 3-substituted product **5a** in 24% yield besides 2-substituted product **4a**. This means the introduction of a methyl group at the 1-position disfavored an attack at 2-position because of an increase of the steric hindrance. Another interesting example is the reaction of resorcinol, in which the formation of di-substituted product **13** was competed with that of mono-substituted product **12** (Entry 13). In this case, the first substitution at the 4-position of resorcinol almost does not increase the steric hindrance at the 6-position.

Conclusion

We consider the BF_3-promoted aromatic substitution reaction of *N*-alkyl α-trifluoromethyl imine to be an efficient way to prepare a variety of *N*-alkyl-1-aryl-2,2,2-trifluoroethylamines. A highly selective removal of the *N*-benzyl or *N*-benzhydryl groups by acid-catalyzed hydrolysis or palladium-catalyzed hydrogenolysis enabled us to synthesize important α-trifluoromethyl amines in good yields. The bioactivities of these new compounds and their potential applications in the pharmaceutical industry are under investigation.

Experimental

All starting materials were obtained commercially and used without purification. Dichloromethane and methanol were dried and preserved on 4 Å molecular sieves. ^{1}H NMR spectra were recorded with tetramethylsilane (TMS) as the internal standard at 90 MHz on a Hitachi R-90H FT spectrometer and at 299.95 MHz on a Varian INOVA-300 FT spectrometer. ^{19}F NMR spectra were recorded on the same spectrometers with hexafluorobenzene as the internal standard, respectively, at 84.7 MHz and at 282.22 MHz. Mass spectra (70 eV) were measured with a Shimadzu QP-5000 instrument. High-resolution mass spectra were measured on a JEOL JMS-SX102A MS spectrometer. Melting points were measured in a glass capillary tube on a heating block and were uncorrected.

Preparation of Imines 1a–c: Trifluoroacetaldehyde ethyl hemiacetal (4.32 g, 30 mmol) was added to a solution of benzylamine (3.21 g, 30 mmol) or benzhydrylamine (5.49 g, 30 mmol) in dry toluene (25 mL). This mixture was stirred at room temperature for 15 min, and then refluxed for 2 h. The solvent was evaporated under reduced pressure, and gave imine **1a** or **1b** as a crude oil. These imines were used without purification.

A solution of 2,2,2-trifluoro-1-(methylamino)ethanol (5.16 g, 40 mmol) in toluene (20 mL) was heated at 80 °C for 2 h, then cooled in an ice-water bath. After being dried over anhydrous calcium chloride, the solution was distilled at atmosphere pressure, giving 3.60 g of imine **1c** (81%, bp 54–56 °C). ^{1}H NMR ($CDCl_3$) δ 7.63 (q, 1H, J = 3.5 Hz), 3.51 (s, 3H). ^{19}F NMR ($CDCl_3$) δ 89.97 (3F, d, J = 3.5 Hz).

General Procedure for Aromatic Substitution with Imine 1: After diethyl ether–boron trifluoride (0.21 g, 1.5 mmol) was added to a solution of indole (0.35 g, 3 mmol) and imine **1a** (0.56 g, 3 mmol) in dried CH_2Cl_2 (10 mL) at 0 °C, the whole stirred at 10 °C for 2 h. Distilled water (10 mL) was added, and the mixture neutralized with a saturated aqueous $NaHCO_3$ solution. Then, the organic layer was separated, and the aqueous layer treated twice with ethyl acetate. The organic phases were combined, dried over anhydrous $MgSO_4$, and evaporated under reduced pressure. The residue was purified by silica-gel column chromatography (eluted with 1:5 (v/v) of ethyl acetate:hexane), giving benzyl[2,2,2-trifluoro-1-(1*H*-indol-3-yl)ethyl]amine (**2a**) in 92% yield.

The substitution reactions of indole with imine **1b** or **1c**, and those of other arenes with **1a**–**c** were conducted in the same way. The spectrum data for all the products are as follows.

Benzyl[2,2,2-trifluoro-1-(1*H*-indol-3-yl)ethyl]amine (2a): A colorless oil. ^{1}H NMR ($CDCl_3$) δ 8.25 (br, 1H), 7.63 (m, 1H), 7.05–7.35 (m, 4H), 7.27 (s, 5H), 4.49 (q, 1H, J = 7.7 Hz), 3.92 (d, 1H, J = 13.8 Hz), 3.75 (d, 1H, J = 13.8 Hz), 1.95 (br, 1H). ^{19}F NMR ($CDCl_3$) δ 88.03 (d, 3F, J = 7.7 Hz). MS *m*/*z* (%) 304 (M^+, 35), 235 (100), 198 (7), 117 (33), 91 (96). Found: C, 67.16; H, 4.96; N, 9.18%. Calcd for $C_{17}H_{15}F_3N_2$: C, 67.10; H, 4.97; N, 9.21%.

Benzyl[2,2,2-trifluoro-1-(1*H*-pyrrol-2-yl)ethyl]amine (3a): Colorless grains, mp 56–57 °C. ^{1}H NMR ($CDCl_3$) δ 8.53 (br, 1H), 7.29 (s, 5H), 6.81 (d, 1H, J = 1.1 Hz), 6.21 (m, 2H), 4.27 (q, 1H, J = 7.2 Hz), 3.84 (d, 1H, J = 13.6 Hz), 3.66 (d, 1H, J = 13.6 Hz), 1.85 (br, 1H). ^{19}F NMR ($CDCl_3$) δ 87.57 (d, 3F, J = 7.2 Hz). MS *m*/*z* (%) 254 (M^+, 18), 185 (76), 148 (10), 106 (50), 91 (100). Found: C, 61.44; H, 5.14; N, 10.96%. Calcd for $C_{13}H_{13}F_3N_2$: C, 61.41; H, 5.15; N, 11.02%.

Benzyl[2,2,2-trifluoro-1-(1-methyl-1*H*-pyrrol-2-yl)ethyl]amine (4a): A colorless oil. ^{1}H NMR ($CDCl_3$) δ 7.29 (s, 5H), 6.60 (d, 1H, J = 2.9 Hz), 6.26 (d, 1H, J = 3.1 Hz), 6.16 (dd, 1H, J = 2.9 and 3.1 Hz), 4.21 (q, 1H, J = 7.3 Hz), 3.92 (d, 1H, J = 13.6 Hz), 3.73 (d, 1H, J = 13.6 Hz), 3.46 (s, 3H), 1.89 (br, 1H). ^{19}F

NMR (CDCl$_3$) δ 88.18 (d, 3F, J = 7.3 Hz). MS m/z (%) 268 (M$^+$, 2), 199 (19), 187 (6), 162 (19), 106 (45), 94 (19), 91 (100). Found: C, 62.64; H, 5.60; N, 10.38%. Calcd for $C_{14}H_{15}F_3N_2$: C, 62.68; H, 5.64; N, 10.44%.

Benzyl[2,2,2-trifluoro-1-(1-methyl-1*H*-pyrrol-3-yl)ethyl]amine (5a): A colorless oil. ^{1}H NMR (CDCl$_3$) δ 7.30 (s, 5H), 6.59 (s, 1H), 6.58 (d, 1H, J = 2.0 Hz), 6.14 (d, 1H, J = 2.0 Hz), 4.04 (q, 1H, J = 7.5 Hz), 3.91 (d, 1H, J = 13.6 Hz), 3.75 (d, 1H, J = 13.6 Hz), 3.63 (s, 3H), 1.70 (br, 1H). ^{19}F NMR (CDCl$_3$) δ 87.19 (d, 3F, J = 7.5 Hz). MS m/z (%) 268 (M$^+$, 2), 199 (44), 186 (5), 163 (37), 162 (25), 112 (17), 106 (50), 94 (31), 91 (100). Found: C, 62.59; H, 5.62; N, 10.41%. Calcd for $C_{14}H_{15}F_3N_2$: C, 62.68; H, 5.64; N, 10.44%.

Benzyl(2,2,2-trifluoro-1-furan-2-yl-ethyl)amine (6a): A yellowish oil. ^{1}H NMR (CDCl$_3$) δ 7.45 (m, 1H), 7.31 (s, 5H), 6.40 (m, 2H), 4.21 (q, 1H, J = 7.3 Hz), 3.92 (d, 1H, J = 13.3 Hz), 3.70 (d, 1H, J = 13.3 Hz), 2.04 (br, 1H). ^{19}F NMR (CDCl$_3$) δ 87.83 (d, 3F, J = 7.3 Hz). MS m/z (%) 255 (M$^+$, 1), 186 (7), 149 (18), 91 (100). HRMS m/z Found: 255.0869. Calcd: 255.0871.

Benzyl[2,2,2-trifluoro-1-thiophen-2-yl]ethyl]amine (7a): A yellowish oil. ^{1}H NMR (CDCl$_3$) δ 7.31 (s, 5H), 7.28 (m, 1H), 7.05 (m, 2H), 4.42 (q, 1H, J = 7.2 Hz), 3.94 (d, 1H, J = 13.5 Hz), 3.72 (d, 1H, J = 13.5 Hz), 1.70 (br, 1H). ^{19}F NMR (CDCl$_3$) δ 87.30 (d, 3F, J = 7.2 Hz). MS m/z (%) 271 (M$^+$, 16), 202 (98), 165 (10), 150 (61), 106 (70), 91(100). Found: C, 57.64; H, 4.43; N, 5.11%. Calcd for $C_{13}H_{12}F_3NS$: C, 57.55; H, 4.46; N, 5.16%.

4-(1-Benzylamino-2,2,2-trifluoroethyl)-*N*,*N*-dimethylaniline (8a): Colorless grains, mp 48–49 °C. ^{1}H NMR (CDCl$_3$) δ 7.28 (s, 5H), 7.23 (d, 2H, J = 8.7 Hz), 6.71 (d, 1H, J = 8.7 Hz), 4.01 (q, 1H, J = 7.5 Hz), 3.85 (d, 1H, J = 13.8 Hz), 3.57 (d, 1H, J = 13.8 Hz), 2.96 (s, 6H), 1.92 (br, 1H). ^{19}F NMR (CDCl$_3$) δ 87.57 (d, 3F, J = 7.5 Hz). MS m/z (%) 308 (M$^+$, 80), 239 (100), 202 (38), 148 (30), 91 (51). Found: C, 66.30; H, 6.20; N, 8.99%. Calcd for $C_{17}H_{19}F_3N_2$: C, 66.22; H, 6.21; N, 9.09%.

4-(1-Benzylamino-2,2,2-trifluoroethyl)phenol (9a): Colorless grains, mp 91–92 °C. ^{1}H NMR (CDCl$_3$) δ 7.28 (s, 5H), 7.27 (d, 2H, J = 8.5 Hz), 6.84 (d, 1H, J = 8.5 Hz), 4.05 (q, 1H, J = 7.5 Hz), 3.83 (d, 1H, J = 13.6 Hz), 3.61 (d, 1H, J = 13.6 Hz), 1.70 (br, 1H). ^{19}F NMR (CDCl$_3$) δ 87.60 (d, 3F, J = 7.5 Hz). MS m/z (%) 281 (M$^+$, 5), 212 (100), 175 (54), 125 (3), 91 (30). Found: C, 64.09; H, 5.01; N, 4.86%. Calcd for $C_{15}H_{14}F_3NO$: C, 64.05; H, 5.02; N, 4.98%.

2-(1-Benzylamino-2,2,2-trifluoroethyl)phenol (10a): A colorless oil. ^{1}H NMR (CDCl$_3$) δ 10.50 (s, 1H), 7.33 (s, 5H), 7.25 (m, 1H), 7.01 (m, 2H), 6.82 (d, 1H, J = 8.3 Hz), 4.27 (q, 1H, J = 7.7 Hz), 3.97 (d, 1H, J = 13.0 Hz), 3.61 (d, 1H, J = 13.0 Hz), 2.36 (br, 1H). ^{19}F NMR (CDCl$_3$) δ 87.26 (d, 3F, J = 7.7 Hz). MS m/z (%) 281 (M$^+$, 29), 212 (66), 127 (4), 106 (12), 91 (100). Found: C, 63.89; H, 5.05; N, 4.82%. Calcd for $C_{15}H_{14}F_3NO$: C, 64.05; H, 5.02; N, 4.98%.

4-(1-Benzylamino-2,2,2-trifluoroethyl)-2,6-dimethylphenol (11a): A colorless oil. ^{1}H NMR (CDCl$_3$) δ 7.29 (s, 5H), 6.99 (s, 2H), 4.70 (br, 1H), 3.98 (q, 1H, J = 7.4 Hz), 3.82 (d, 1H, J = 13.6 Hz), 3.62 (d, 1H, J = 13.6 Hz), 2.25 (s, 6H), 1.60 (br, 1H). ^{19}F NMR (CDCl$_3$) δ 87.79 (d, 3F, J = 7.5 Hz). MS m/z (%) 309 (M$^+$, 21), 240 (100), 218 (8), 203 (11), 150 (8), 106 (50), 91 (96). Found: C, 65.89; H, 5.91; N, 4.48%. Calcd for $C_{17}H_{18}F_3NO$: C, 66.01; H, 5.87; N, 4.53%.

4-(1-Benzylamino-2,2,2-trifluoroethyl)benzene-1,3-diol (12): A colorless oil. ^{1}H NMR (CDCl$_3$) δ 7.30 (m, 5H), 6.86 (d, 2H, J = 7.9 Hz), 6.44 (s, 1H), 6.40 (d, 1H, J = 7.9 Hz), 4.19 (q, 1H, J = 7.5 Hz), 3.94 (d, 1H, J = 13.3 Hz), 3.61 (d, 1H, J = 13.3 Hz). ^{19}F NMR (CDCl$_3$) δ 86.98 (d, 3F, J = 7.5 Hz). MS m/z (%) 297 (M$^+$, 14), 228 (49), 190 (53), 148 (21), 120 (46), 106 (100), 91 (95). Found: C, 60.49; H, 4.74; N, 4.74%. Calcd for $C_{15}H_{14}F_3NO_2$: C, 60.60; H, 4.75; N, 4.71%.

4,6-Bis(1-benzylamino-2,2,2-trifluoroethyl)benzene-1,3-diol (13): A colorless oil. ^{1}H NMR (CDCl$_3$) δ 10.66 (br, 2H), 7.29 (m, 10H), 6.69, 6.57 (s, 1H), 6.48 (s, 1H), 4.19 (q, 2H, J = 8.1 Hz), 3.99 (d, 2H, J = 13.4 Hz), 3.60 (d, 1H, J = 13.4 Hz), 2.43 (br, 2H). ^{19}F NMR (CDCl$_3$) δ 86.95 (d, 3F, J = 8.1 Hz). MS m/z (%) 484 (M$^+$, 4), 415 (7), 308 (20), 286 (7), 149 (4), 106 (63), 91 (100). Found: C, 59.69; H, 4.60; N, 5.71%. Calcd for $C_{24}H_{22}F_6N_2O_2$: C, 59.50; H, 4.58; N, 5.78%.

Benzhydryl[2,2,2-trifluoro-1-(1*H*-indol-3-yl)ethyl]amine (2b): A colorless oil. ^{1}H NMR (CDCl$_3$) δ 8.18 (br, 1H), 7.33 (s, 5H), 7.24 (s, 5H), 7.01–7.69 (m, 5H), 4.88 (s, 1H), 4.32 (m, 1H), 2.30 (m, br, 1H). ^{19}F NMR (CDCl$_3$) δ 88.21 (d, 3F, J = 7.6 Hz). MS m/z (%) 380 (M$^+$, 4), 311 (17) 263 (28), 261 (21), 182 (100), 167 (91), 106 (16). Found: C, 72.49; H, 5.01; N, 7.21%. Calcd for $C_{23}H_{19}F_3N_2$: C, 72.62; H, 5.03; N, 7.36%.

Benzhydryl[2,2,2-trifluoro-1-(1*H*-pyrrol-2-yl)ethyl]amine (3b): Colorless plates, mp 91–93 °C. ^{1}H NMR (CDCl$_3$) δ 8.35 (br, 1H), 7.32 (s, 5H), 7.28 (s, 5H), 6.80 (m, 1H), 6.19 (m, 2H), 4.82 (d, 1H, J = 5.3 Hz), 4.15 (m, 1H), 2.30 (m, br, 1H). ^{19}F NMR (CDCl$_3$) δ 87.74 (d, 3F, J = 7.2 Hz). MS m/z (%) 330 (M$^+$, 0.3), 263 (14), 261 (18), 182 (24), 167 (100), 165 (21), 152 (13), 128 (12), 106 (10). Found: C, 68.99; H, 5.18; N, 8.36%. Calcd for $C_{19}H_{17}F_3N_2$: C, 69.08; H, 5.19; N, 8.48%.

Benzhydryl[2,2,2-trifluoro-1-(1-methyl-1*H*-pyrrol-2-yl)ethyl]amine (4b): Colorless plates, mp 79–81 °C. ^{1}H NMR (CDCl$_3$) δ 7.32 (s, 5H), 7.29 (s, 5H), 6.58 (m, 1H), 6.24 (m, 1H), 6.17 (m, 1H), 4.84 (d, 1H, J = 3.1 Hz), 4.10 (m, 1H), 3.25 (s, 3H), 2.20 (m, br, 1H). ^{19}F NMR (CDCl$_3$) δ 87.60 (d, 3F, J = 7.1 Hz). MS m/z (%) 344 (M$^+$, 0.2), 263 (10), 262 (29), 182 (100), 167 (90), 165 (30), 162 (68), 152 (16), 112 (16), 106 (12), 104 (20), 94 (33). Found: C, 69.59; H, 5.55; N, 8.08%. Calcd for $C_{20}H_{19}F_3N_2$: C, 69.75; H, 5.56; N, 8.13%.

Benzhydryl[2,2,2-trifluoro-1-(furan-2-yl)ethyl]amine (6b): A yellowish oil. ^{1}H NMR (CDCl$_3$) δ 7.42 (m, 1H), 7.33 (s, 5H), 7.27 (s, 5H), 6.35 (m, 2H), 4.78 (s, 1H), 4.18 (m, 1H), 2.35 (br, 1H). ^{19}F NMR (CDCl$_3$) δ 88.06 (d, 3F, J = 7.2 Hz). MS m/z (%) 331 (M$^+$, 3), 263 (28), 262 (20), 254 (26), 182 (13), 167 (94), 165 (28), 152 (8), 149 (100), 104 (32). HRMS m/z Found: 331.1182. Calcd: 331.1184.

Benzhydryl[2,2,2-trifluoro-1-(thiophen-2-yl)ethyl]amine (7b): A yellowish oil. ^{1}H NMR (CDCl$_3$) δ 7.34 (s, 5H), 7.26 (s, 5H), 7.23 (m, 1H), 6.99 (m, 2H), 4.87 (d, 1H, J = 2.9 Hz), 4.30 (m, 1H), 2.23 (m, br, 1H). ^{19}F NMR (CDCl$_3$) δ 87.51 (d, 3F, J = 7.4 Hz). MS m/z (%) 347 (M$^+$, 0.3), 278 (7), 270 (24), 263 (19), 262 (11), 182 (45), 167 (90), 165 (100), 152 (17), 115 (23), 104 (23). Found: C, 65.86; H, 4.65; N, 3.87%. Calcd for $C_{19}H_{16}F_3NS$: C, 65.69; H, 4.64; N, 4.03%.

4-[1-(Benzhydrylamino)-2,2,2-trifluoroethyl]-*N*,*N*-dimethylaniline (8b): Colorless crystals, mp 75–76 °C. ^{1}H NMR (CDCl$_3$) δ 7.34 (s, 5H), 7.27 (s, 5H), 7.15 (d, 2H, J = 8.8 Hz), 6.71 (d, 2H, J = 8.8 Hz), 4.73 (d, 1H, J = 0.9 Hz), 3.92 (m, 1H, J = 7.9 Hz), 2.98 (s, 6H), 2.32 (m, br, 1H). ^{19}F NMR (CDCl$_3$) δ 87.92 (d, 3F, J = 7.9 Hz). MS m/z (%) 384 (M$^+$, 6), 315 (12), 262 (13), 202 (20), 167 (100), 165 (21), 152 (21), 122 (11). Found: C, 71.79; H, 6.02; N, 7.23%. Calcd for $C_{23}H_{23}F_3N_2$: C, 71.86; H, 6.03; N, 7.29%.

4-[1-(Benzhydrylamino)-2,2,2-trifluoroethyl]phenol (9b): Colorless crystals, mp 92–94 °C. ^{1}H NMR (CDCl$_3$) δ 7.32 (s, 5H), 7.26 (s, 5H), 7.18 (d, 2H, J = 8.3 Hz), 6.83 (d, 2H, J = 8.3 Hz), 4.69 (d, 1H, J = 2.6 Hz), 4.02 (m, 1H, J = 7.6 Hz), 2.24 (m, br, 1H). ^{19}F NMR (CDCl$_3$) δ 87.96 (d, 3F, J = 7.6 Hz). MS *m*/*z* (%) 357 (M$^+$, 2), 288 (16), 280 (12), 210 (5), 182 (26), 167 (100), 106 (42). Found: C, 70.50; H, 5.07; N, 3.76%. Calcd for $C_{21}H_{18}F_3NO$: C, 70.58; H, 5.08; N, 3.92%.

2-[1-(Benzhydrylamino)-2,2,2-trifluoroethyl]phenol (10b): A colorless oil. ^{1}H NMR (CDCl$_3$) δ 10.10 (s, 1H), 7.27 (s, 5H), 7.10–7.40 (m, 6H), 6.80–6.93 (m, 3H), 4.86 (d, 2H, J = 12.1 Hz), 4.13 (q, 1H, J = 7.9 Hz), 2.82 (d, br, 1H, J = 12.1 Hz). ^{19}F NMR (CDCl$_3$) δ 87.61 (d, 3F, J = 7.9 Hz). MS *m*/*z* (%) 357 (M$^+$, 6), 280 (5), 182 (16), 167 (100), 152 (35), 106 (36). Found: C, 70.31; H, 5.10; N, 3.73%. Calcd for $C_{21}H_{18}F_3NO$: C, 70.58; H, 5.08; N, 3.92%.

4-[1-(Benzhydrylamino)-2,2,2-trifluoroethyl]-2,6-dimethylphenol (11b): A colorless oil. ^{1}H NMR (CDCl$_3$) δ 7.33 (s, 5H), 7.27 (s, 5H), 6.88 (s, 2H), 4.71 (d, 2H, J = 3.1 Hz), 4.68 (s, br, 1H), 3.85 (d, 1H, J = 8.3 Hz), 2.35 (d, br, 1H, J = 3.1 Hz), 2.24 (s, 6H). ^{19}F NMR (CDCl$_3$) δ 88.14 (d, 3F, J = 8.3 Hz). MS *m*/*z* (%) 385 (M$^+$, 1), 316 (6), 263 (4), 262 (6), 182 (92), 167 (100), 106 (41). Found: C, 71.48; H, 5.78; N, 3.53%. Calcd for $C_{23}H_{22}F_3NO$: C, 71.67; H, 5.75; N, 3.63%.

4-[1-(Benzhydrylamino)-2,2,2-trifluoroethyl]-2-methoxyphenol (14b): A colorless oil. ^{1}H NMR (CDCl$_3$) δ 7.33 (s, 5H), 7.27 (s, 5H), 6.93 (d, 1H, J = 8.6 Hz), 6.80 (s, 1H), 6.78 (d, 1H, J = 8.6 Hz), 5.66 (s, 1H), 4.71 (d, 1H, J = 4.4 Hz), 4.01 (m, 1H, J = 8.3 Hz), 3.86 (s, 3H), 2.28 (m, br, 1H). ^{19}F NMR (CDCl$_3$) δ 88.01 (d, 3F, J = 8.3 Hz). MS *m*/*z* (%) 387 (M$^+$, 1), 205 (22), 182 (100), 167 (87), 165 (21), 152 (18), 106 (49). Found: C, 68.06; H, 5.17; N, 3.46%. Calcd for $C_{22}H_{20}F_3NO_2$: C, 68.21; H, 5.20; N, 3.62%.

4-[1-(Benzhydrylamino)-2,2,2-trifluoroethyl]naphthalen-1-ol (16b): Colorless plates, mp 106–107 °C. ^{1}H NMR (CDCl$_3$) δ 11.11 (s, 1H), 8.33 (m, 1H), 7.81 (m, 1H), 7.10–7.55 (m, 13H), 6.85 (d, 2H, J = 8.4 Hz), 4.93 (d, 1H, J = 12.5 Hz), 4.24 (q, 1H, J = 7.7 Hz), 2.93 (d, br, 1H, J = 12.5 Hz). ^{19}F NMR (CDCl$_3$) δ 87.62 (d, 3F, J = 7.6 Hz). MS *m*/*z* (%) 407 (M$^+$, 3), 224 (33), 196 (17), 182 (9), 167 (100), 165 (20), 152 (15), 146 (18), 127 (12), 106 (39). Found: C, 73.58; H, 4.94; N, 3.42%. Calcd for $C_{25}H_{20}F_3NO$: C, 73.70; H, 4.95; N, 3.44%.

4-Benzhydrylnaphthalen-1-ol (18): ^{1}H NMR (CDCl$_3$) δ 8.22 (m, 1H), 7.92 (m, 1H), 7.07–7.53 (m, 13H), 6.92 (d, 1H, J = 7.9 Hz), 6.17 (s, 1H), 5.12 (s, br, 1H). MS *m*/*z* (%) 310 (M$^+$, 100), 233 (65), 231 (43), 215 (19), 202 (19), 105 (51), 77 (47). HRMS *m*/*z* Found: 310.1358. Calcd: 310.1358.

1-[1-(Benzhydrylamino)-2,2,2-trifluoroethyl]naphthalen-2-ol (17b): A yellowish oil. ^{1}H NMR (CDCl$_3$) δ 11.49 (s, 1H), 7.80 (m, 3H), 7.28 (s, 10H), 7.25 (m, 1H), 7.07 (m, 2H), 5.10 (q, 1H, J = 7.5 Hz), 4.88 (d, 1H, J = 12.7 Hz), 2.96 (d, br, 1H, J = 12.7 Hz). ^{19}F NMR (CDCl$_3$) δ 88.68 (d, 3F, J = 7.5 Hz). MS *m*/*z* (%) 407 (M$^+$, 3), 224 (6), 196 (7), 182 (3), 177 (4), 167 (100), 165 (20), 152 (15), 146 (6), 127 (6), 106 (16). Found: C, 73.88; H, 4.96; N, 3.38%. Calcd for $C_{25}H_{20}F_3NO$: C, 73.70; H, 4.95; N, 3.44%.

1-Benzhydrylnaphthalen-2-ol (19): ^{1}H NMR (CDCl$_3$) δ 7.98 (d, 1H, J = 7.5 Hz), 7.72 (m, 2H), 7.28 (s, 10H), 7.10–7.44 (m, 2H), 6.95 (d, 1H, J = 7.5 Hz), 6.41 (s, 1H), 5.17 (s, br, 1H). MS *m*/*z* (%) 310 (M$^+$, 80), 281 (11), 231 (69), 215 (31), 202 (33), 167 (100), 165 (65), 105 (17), 77 (15). HRMS *m*/*z* Found: 310.1356. Calcd: 310.1358.

Methyl[2,2,2-trifluoro-1-(1*H*-indol-3-yl)ethyl]amine (2c): Colorless needles, mp 102–103 °C. ^{1}H NMR (CDCl$_3$) δ 8.42 (br, 1H), 7.72 (m, 1H), 7.10–7.44 (m, 4H), 4.39 (q, 1H, J = 7.7 Hz), 2.50 (s, 3H), 1.78 (br, 1H). ^{19}F NMR (CDCl$_3$) δ 87.90 (d, 3F, J = 7.7 Hz). MS *m*/*z* (%) 228 (M$^+$, 23), 198 (19), 197 (28), 159 (100), 148 (15), 118 (49). Found: C, 57.84; H, 4.85; N, 12.23%. Calcd for $C_{11}H_{11}F_3N_2$: C, 57.89; H, 4.86; N, 12.28%.

Methyl[2,2,2-trifluoro-1-(1*H*-pyrrol-2-yl)ethyl]amine (3c): A yellowish oil. ^{1}H NMR (CDCl$_3$) δ 8.72 (br, 1H), 6.79 (m, 1H), 6.21 (m, 2H), 4.16 (q, 1H, J = 7.0 Hz), 2.40 (s, 3H), 1.74 (br, 1H). ^{19}F NMR (CDCl$_3$) δ 87.51 (d, 3F, J = 7.0 Hz). MS *m*/*z* (%) 178 (M$^+$, 18), 149 (26), 128 (29),109 (52), 85 (19), 82 (23), 69 (53). Found: C, 47.32; H, 5.12; N, 15.58%. Calcd for $C_7H_9F_3N_2$: C, 47.19; H, 5.09; N, 15.72%.

Methyl[2,2,2-trifluoro-1-(1-methyl-1*H*-pyrrol-2-yl)ethyl]amine (4c): A yellowish oil. ^{1}H NMR (CDCl$_3$) δ 6.61 (d, 1H, J = 2.6 Hz), 6.20 (d, 1H, J = 2.8 Hz), 6.14 (dd, 1H, J = 2.6 and 2.8 Hz), 4.12 (q, 1H, J = 7.2 Hz), 3.63 (s, 3H), 2.45 (s, 3H), 1.51 (br, 1H). ^{19}F NMR (CDCl$_3$) δ 88.30 (d, 3F, J = 7.2 Hz). MS *m*/*z* (%) 192 (M$^+$, 12), 162 (35), 149 (86), 123 (78), 112 (32), 95 (35), 82 (100). Found: C, 50.21; H, 5.75; N, 14.43%. Calcd for $C_8H_{11}F_3N_2$: C, 50.00; H, 5.77; N, 14.58%.

Methyl[2,2,2-trifluoro-1-(1-methyl-1*H*-pyrrol-3-yl)ethyl]amine (5c): A yellowish oil. ^{1}H NMR (CDCl$_3$) δ 6.60 (d, 1H, J = 2.8 Hz), 6.56 (s, 1H), 6.13 (d, 1H, J = 2.8 Hz), 3.91 (q, 1H, J = 7.5 Hz), 3.61 (s, 3H), 2.45 (s, 3H), 1.55 (br, 1H).). ^{19}F NMR (CDCl$_3$) δ 87.21 (d, 3F, J = 7.5 Hz). MS *m*/*z* (%) 192 (M$^+$, 10), 162 (50), 149 (35), 123 (100), 112 (32), 82 (91), 69 (68). Found: C, 50.18; H, 5.76; N, 14.52%. Calcd for $C_8H_{11}F_3N_2$: C, 50.00; H, 5.77; N, 14.58%.

***N*,*N*-Dimethyl-4-[2,2,2-trifluoro-1-(methylamino)ethyl]aniline (8c):** A colorless oil. ^{1}H NMR (CDCl$_3$) δ 7.23 (d, 2H, J = 8.6 Hz), 6.71 (d, 2H, J = 8.6 Hz), 3.90 (q, 1H, J = 7.7 Hz), 2.96 (s, 6H), 2.39 (s, 3H), 1.93 (br, 1H). ^{19}F NMR (CDCl$_3$) δ 87.48 (d, 3F, J = 7.7 Hz). MS *m*/*z* (%) 232 (M$^+$, 3), 202 (100), 163 (17), 126 (12). Found: C, 57.03; H, 6.52; N, 11.97%. Calcd for $C_{11}H_{15}F_3N_2$: C, 56.89; H, 6.51; N, 12.06%.

4-[2,2,2-Trifluoro-1-(methylamino)ethyl]phenol (9c): Colorless plates, mp 122–123 °C. ^{1}H NMR (CDCl$_3$) δ 7.26 (d, 2H, J = 8.3 Hz), 6.83 (d, 2H, J = 8.3 Hz), 3.95 (q, 1H, J = 7.5 Hz), 2.80 (br, 2H), 2.40 (s, 3H). ^{19}F NMR (CDCl$_3$) δ 87.60 (d, 3F, J = 7.5 Hz). MS *m*/*z* (%) 205 (M$^+$, 3), 175 (8), 156 (2), 136 (100), 125 (15). Found: C, 52.72; H, 4.90; N, 6.74%. Calcd for $C_9H_{10}F_3NO$: C, 52.68; H, 4.91; N, 6.83%.

4-[2,2,2-Trifluoro-1-(methylamino)ethyl]-2-methoxyphenol (14c): Colorless grains, mp 106–107 °C. ^{1}H NMR (CDCl$_3$) δ 6.90 (s, 3H), 3.94 (q, 1H, J = 7.5 Hz), 3.91 (s, 3H), 2.40 (s, 3H). ^{19}F NMR (CDCl$_3$) δ 87.48 (d, 3F, J = 7.5 Hz). MS *m*/*z* (%) 235 (M$^+$, 12), 205 (6), 166 (100), 151 (17). Found: C, 51.11; H, 5.14; N, 5.91%. Calcd for $C_{10}H_{12}F_3NO_2$: C, 51.07; H, 5.14; N, 5.96%.

1-[2,2,2-Trifluoro-1-(methylamino)ethyl]naphthalen-2-ol (17c): Colorless needles, mp 135–136 °C. ^{1}H NMR (CDCl$_3$) δ 7.78 (d, 2H, J = 8.5 Hz), 7.24–7.60 (m, 3H), 7.10 (d, 1H, J = 9.0 Hz), 5.13 (q, 1H, J = 7.3 Hz), 2.51 (s, 3H). ^{19}F NMR (CDCl$_3$) δ 88.12 (d, 3F, J = 7.3 Hz). MS *m*/*z* (%) 255 (M$^+$, 26), 196 (20), 186 (100), 177 (12), 146 (12), 127 (14), 115 (13), 93 (36). Found: C, 61.19; H, 4.72; N, 5.44%. Calcd for $C_{13}H_{12}F_3NO$: C, 61.17; H, 4.74; N, 5.49%.

Hydrolysis of 1-[1-(benzhydrylamino)-2,2,2-trifluoroethyl]naphthalen-2-ol (17b): A suspension of compound **17b** (1.22

g, 3.0 mmol) in 6 M aqueous HCl (8 mL) was heated and refluxed with vigorous stirring for 8 h. After being cooled, the mixture was poured into 20 mL of cold water, and then neutralized with a saturated aqueous $NaHCO_3$ solution. After about 20 mL of ethyl acetate was added, the mixture stirred for several minutes. The organic layer was separated, and the aqueous layer treated twice with ethyl acetate. The organic phases were combined, dried over anhydrous $MgSO_4$, and evaporated under reduced pressure. The residue was purified by silica-gel column chromatography (eluted with 1 : 3 (v/v) of ethyl acetate: hexane), giving 0.57 g (79%) of 1-(1-amino-2,2,2-trifluoroethyl)naphthalen-2-ol (**17d**).

The other *N*-benzhydryl amines in Table 3 were hydrolyzed by the same procedures.

2,2,2-Trifluoro-1-(thiophen-2-yl)ethylamine (7d): A colorless oil. ^{1}H NMR ($CDCl_3$) δ 7.33 (d, 1H, J = 4.8 Hz), 7.10 (d, 1H, J = 3.7 Hz), 7.02 (dd, 1H, J = 4.8 and 3.7 Hz), 4.67 (q, 1H, J = 7.4 Hz), 1.85 (br, 2H). ^{19}F NMR ($CDCl_3$) δ 84.39 (d, 3F, J = 7.4 Hz). MS *m*/*z* (%) 181 (M$^+$, 26), 165 (5), 112 (100), 110 (23), 85 (92). Found: C, 39.92; H, 3.41; N, 7.48%. Calcd for $C_6H_6F_3NS$: C, 39.77; H, 3.34; N, 7.73%.

4-(1-Amino-2,2,2-trifluoroethyl)-*N*,*N*-dimethylaniline (8d): Colorless crystals, mp 62–64 °C. ^{1}H NMR ($CDCl_3$) δ 7.28 (d, 2H, J = 8.6 Hz), 6.70 (d, 2H, J = 8.6 Hz), 4.29 (q, 1H, J = 7.7 Hz), 2.95 (s, 6H), 1.71 (br, 2H). ^{19}F NMR ($CDCl_3$) δ 84.87 (d, 3F, J = 7.7 Hz). MS *m*/*z* (%) 218 (M$^+$, 30), 202 (8), 149 (100), 133 (21), 122 (19), 88 (33). Found: C, 55.11; H, 5.98; N, 12.73%. Calcd for $C_{10}H_{13}F_3N_2$: C, 55.04; H, 6.00; N, 12.84%.

4-(1-Amino-2,2,2-trifluoroethyl)phenol (9d): Colorless needles, mp 138.5–139.5 °C. ^{1}H NMR (acetone-d_6) δ 8.37 (br, 1H), 7.33 (d, 2H, J = 8.4 Hz), 6.84 (d, 2H, J = 8.4 Hz), 4.42 (q, 1H, J = 7.7 Hz), 2.79 (br, 2H). ^{19}F NMR (acetone-d_6) δ 87.35 (d, 3F, J = 7.7 Hz). MS *m*/*z* (%) 191 (M$^+$, 11), 175 (4), 122 (100), 95 (56), 77 (39). Found: C, 50.31; H, 4.23; N, 7.24%. Calcd for $C_8H_8F_3NO$: C, 50.27; H, 4.22; N, 7.33%.

2-(1-Amino-2,2,2-trifluoroethyl)phenol (10d): Colorless needles, mp 82–83 °C. ^{1}H NMR ($CDCl_3$) δ 9.80 (br, 1H), 7.30 (d, 1H, J = 8.1 Hz), 6.93–7.20 (m, 2H), 6.80 (d, 1H, J = 7.7 Hz), 4.63 (q, 1H, J = 7.5 Hz), 2.16 (br, 2H). ^{19}F NMR ($CDCl_3$) δ 85.66 (d, 3F, J = 7.5 Hz). MS *m*/*z* (%) 191 (M$^+$, 25), 175 (9), 155 (8), 149 (13), 122 (100), 95 (24), 77 (30). Found: C, 50.33; H, 4.22; N, 7.21%. Calcd for $C_8H_8F_3NO$: C, 50.27; H, 4.22; N, 7.33%.

4-(1-Amino-2,2,2-trifluoroethyl)-2,6-dimethylphenol (11d): Colorless needles, mp 124–125 °C. ^{1}H NMR ($CDCl_3$) δ 7.03 (s, 2H), 4.25 (q, 1H, J = 7.5 Hz), 2.25 (s, 6H), 1.80 (br, 2H). ^{19}F NMR ($CDCl_3$) δ 84.99 (d, 3F, J = 7.5 Hz). MS *m*/*z* (%) 219 (M$^+$, 25), 150 (100), 136 (5), 123 (35), 108 (15), 105 (19), 69 (41). Found: C, 54.93; H, 5.53; N, 6.29%. Calcd for $C_{10}H_{12}F_3NO$: C, 54.79; H, 5.52; N, 6.39%.

4-(1-Amino-2,2,2-trifluoroethyl)-2-methoxyphenol (14d): Colorless crystals, mp 132–133 °C. ^{1}H NMR ($CDCl_3$) δ 7.00 (d, 1H, J = 8.6 Hz), 6.92 (s, 1H), 6.87 (d, 1H, J = 8.6 Hz), 4.34 (q, 1H, J = 7.0 Hz), 3.91 (s, 3H), 1.63 (br, 3H). ^{19}F NMR ($CDCl_3$) δ 84.93 (d, 3F, J = 7.0 Hz). MS *m*/*z* (%) 221 (M$^+$, 21), 205 (4), 152 (100), 150 (14), 137 (19), 125 (14), 110 (26), 93 (33), 69 (30). Found: C, 48.93; H, 4.56; N, 6.27%. Calcd for $C_9H_{10}F_3NO_2$: C, 48.87; H, 4.56; N, 6.33%.

4-(1-Amino-2,2,2-trifluoroethyl)naphthalen-1-ol (15d): Colorless needles, mp 109–110 °C. ^{1}H NMR ($CDCl_3$) δ 8.27 (m, 1H), 7.75 (m, 1H), 7.47 (m, 2H), 7.29 (d, 1H, J = 8.6 Hz), 7.25 (s, 1H), 7.04 (d, 1H, J = 8.6 Hz), 4.67 (q, 1H, J = 7.5 Hz), 2.40 (br, 2H). ^{19}F NMR ($CDCl_3$) δ 85.69 (d, 3F, J = 7.5 Hz). MS *m*/*z* (%) 241 (M$^+$, 43), 224 (100), 196 (46), 172 (26), 146 (31), 127 (38), 115 (23). Found: C, 59.82; H, 4.16; N, 5.75%. Calcd for $C_{12}H_{10}F_3NO$: C, 59.75; H, 4.18; N, 5.81%.

1-(1-Amino-2,2,2-trifluoroethyl)naphthalen-2-ol (17d): Colorless needles, mp 106–107 °C. ^{1}H NMR ($CDCl_3$) δ 11.14 (br, 1H), 7.76 (d, 3H, J = 8.8 Hz), 7.49 (m, 1H), 7.39 (m, 1H), 7.11 (d, 1H, J = 8.8 Hz), 5.60 (q, 1H, J = 7.0 Hz), 2.23 (br, 2H). ^{19}F NMR ($CDCl_3$) δ 86.66 (d, 3F, J = 7.0 Hz). MS *m*/*z* (%) 241 (M$^+$, 31), 224 (15), 196 (28), 172 (100), 146 (22), 127 (55), 115 (27). Found: C, 59.80; H, 4.17; N, 5.76%. Calcd for $C_{12}H_{10}F_3NO$: C, 59.75; H, 4.18; N, 5.81%.

Hydrogenolysis of benzyl[2,2,2-trifluoro-1-(1*H*-indol-3-yl)-ethyl]amine (2a): A mixture of compound **2a** (0.61 g, 2.0 mmol) and 5% palladium–charcoal (0.42 g) in methanol (10 mL) was stirred for 12 h under a hydrogen atmosphere at room temperature. The reaction mixture was then filtered through a Celite pad, and the filtrate concentrated by evaporation under reduced pressure. The residue was separated on a silica-gel column eluted with ethyl acetate/hexane (1/4–1/2, v/v). The first eluted material was *N*-methyl amine **2c** (0.055 g, 12%), and the second amine **2d** (0.32 g, 75%).

The Pd-catalyzed hydrogenolysis of the other substrates listed in Table 4 was performed by the same procedures.

2,2,2-Trifluoro-1-(1*H*-indol-3-yl)ethylamine (2d): Colorless needles, mp 130–131 °C. ^{1}H NMR (acetone-d_6) δ 10.35 (br, 1H), 7.75 (m, 1H), 7.10–7.60 (m, 4H), 4.84 (q, 1H, J = 7.7 Hz), 2.30 (br, 2H). ^{19}F NMR (acetone-d_6) δ 87.42 (d, 3F, J = 7.7 Hz). MS *m*/*z* (%) 214 (M$^+$, 33), 197 (44), 145 (100), 118 (76). Found: C, 56.34; H, 4.25; N, 12.82%. Calcd for $C_{10}H_9F_3N_2$: C, 56.06; H, 4.24; N, 13.08%.

2,2,2- Trifluoro-1-(1*H*-pyrrol-2-yl)ethylamine (3d): Colorless needles, mp 70 °C. ^{1}H NMR ($CDCl_3$) δ 8.57 (br, 1H), 6.79 (s, 1H), 6.21 (s, 2H), 4.51 (q, 1H, J = 7.0 Hz), 1.69 (br, 2H). ^{19}F NMR ($CDCl_3$) δ 84.59 (d, 3F, J = 7.0 Hz). MS *m*/*z* (%) 164 (M$^+$, 43), 148 (64), 128 (51), 95 (100), 69 (70). Found: C, 44.01; H, 4.31; N, 16.99%. Calcd for $C_6H_7F_3N_2$: C, 43.91; H, 4.30; N, 17.07%.

2,2,2-Trifluoro-1-(1-methyl-1*H*-pyrrol-2-yl)ethylamine (4d): A colorless oil. ^{1}H NMR ($CDCl_3$) δ 6.60 (dd, 1H, J = 2.7 Hz and 1.9 Hz), 6.25 (dd, 1H, J = 3.7 and 1.9 Hz), 6.10 (dd, 1H, J = 3.7 and 2.7 Hz), 4.39 (q, 1H, J = 7.0 Hz), 3.63 (s, 3H), 1.66 (br, 2H). ^{19}F NMR ($CDCl_3$) δ 85.30 (d, 3F, J = 7.0 Hz). MS *m*/*z* (%) 178 (M$^+$, 30), 162 (94), 149 (25), 123 (26), 112 (28), 109 (70), 106 (28), 82 (100). Found: C, 47.31; H, 5.11; N, 15.53%. Calcd for $C_7H_9F_3N_2$: C, 47.19; H, 5.09; N, 15.72%.

2,2,2-Trifluoro-1-(1-methyl-1*H*-pyrrol-3-yl)ethylamine (5d): A colorless oil. ^{1}H NMR ($CDCl_3$) δ 6.66 (s, 1H), 6.57 (d, 1H, J = 2.4 Hz), 6.17 (d, 1H, J = 2.4 Hz), 4.31 (q, 1H, J = 7.5 Hz), 3.63 (s, 3H), 1.80 (br, 2H). ^{19}F NMR ($CDCl_3$) δ 84.05 (d, 3F, J = 7.5 Hz). MS *m*/*z* (%) 178 (M$^+$, 32), 162 (96), 123 (15), 112 (30), 109 (89), 82 (100). Found: C, 47.35; H, 5.12; N, 15.49%. Calcd for $C_7H_9F_3N_2$: C, 47.19; H, 5.09; N, 15.72%.

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